



# Journal of Hymenoptera Research

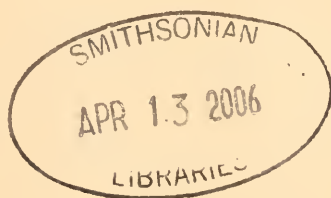
Volume 15, Number 1

April 2006

ISSN #1070-9428

## CONTENTS

GIBSON, G. A. P. A revised concept of <i>Spalangia philippinensis</i> Fullaway, 1917 (Hymenoptera: Pteromalidae) .....	1
KIMSEY, L. S. and M. S. WASBAUER. Phylogeny and checklist of the nocturnal tephritids of the Western Hemisphere (Hymenoptera: Tephritidae: Brachycistidinae) .....	9
KUHLMANN, M. Fauna and biogeography of the bees and wasps of the Cook Islands (Hymenoptera Aculeata) .....	26
PINTO, J. D. A review of the New World genera of Trichogrammatidae (Hymenoptera) .....	38
PULAWSKI, W. J. Nomenclatural changes in Old World Crabronidae (Hymenoptera), with taxonomic comments and new distribution records .....	164
PUNZO, F. Plants whose flowers are utilized by adults of <i>Pepsis grossa</i> Fabricius (Hymenoptera: Pompilidae) as a source of nectar .....	171
NOTE:	
STARR, C. K. and A. W. HOOK. <i>Polistes goeldii</i> (Hymenoptera: Vespidae) is a widespread but rare social wasp .....	177



# INTERNATIONAL SOCIETY OF HYMENOPTERISTS

Organized 1982; Incorporated 1991

---

## OFFICERS FOR 2006

Denis Brothers, *President*  
Michael E. Schauff, *President-Elect*  
Michael W. Gates, *Secretary*  
Justin O. Schmidt, *Treasurer*  
Gavin R. Broad, *Editor*

---

## Subject Editors

### SYMPHYTA AND PARASITICA

*Biology:* Mark Shaw  
*Systematics:* Donald Quicke

### ACULEATA

*Biology:* Sydney Cameron  
*Systematics:* Wojciech Pulawski

---

All correspondence concerning Society business should be mailed to the appropriate officer at the following addresses: President, School of Botany and Zoology, University of KwaZulu-Natal, Private Bag X01, Scottsville, South Africa; Secretary, Southwestern Biological Institute, 1961 W. Brichta Dr., Tucson, AZ 85745, USA; Treasurer, PO Box 37012, c/o Smithsonian Institution, MNMH, MRC168, Washington, DC 20013-7012, USA; Editor, Centre for Ecology & Hydrology, Monks Wood, Abbots Ripton, Huntingdon, Peterborough PE28 2LS, UK.

**Membership.** Members shall be persons who have demonstrated interest in the science of entomology. Annual dues for members are US\$40.00 per year (US\$35.00 if paid before 1 February), payable to The International Society of Hymenopterists. Requests for membership should be sent to the Treasurer (address above). Information on membership and other details of the Society may be found on the World Wide Web at <http://IRIS.biosci.ohio-state.edu/ish>.

**Journal.** The *Journal of Hymenoptera Research* is published twice a year by the International Society of Hymenopterists, % Department of Entomology, Smithsonian Institution, Washington, D.C. 20560-0168, U.S.A. Members in good standing receive the *Journal*. Nonmember subscriptions are \$60.00 (U.S. currency) per year.

The Society does not exchange its publications for those of other societies.

**Please see inside back cover of this issue for information regarding preparation of manuscripts.**

---

## Statement of Ownership

Title of Publication: Journal of Hymenoptera Research.

Frequency of Issue: Twice a year.

Location of Office of Publication, Business Office of Publisher and Owner: International Society of Hymenopterists, 0 Department of Entomology, Smithsonian Institution, 10th and Constitution NW, Washington, D.C. 20560-0168, U.S.A.

Editor: Gavin R. Broad, Centre for Ecology & Hydrology, Monks Wood, Abbots Ripton, Huntingdon, Peterborough PE28 2LS, UK.

Managing Editor and Known Bondholders or other Security Holders: none.

---

This issue was mailed 28 March 2006

## A Revised Concept of *Spalangia philippinensis* Fullaway, 1917 (Hymenoptera: Pteromalidae)

GARY A. P. GIBSON

Agriculture and Agri-Food Canada, Biodiversity and Integrated Pest Management, K. W. Neatby Bldg., 960 Carling Avenue, Ottawa, Ontario, Canada, K1A 0C6

\*Address for correspondence: Dr. Gary Gibson, K.W. Neatby Building, 960 Carling Avenue, Ottawa, Ontario, Canada K1A 0C6; e-mail: gibsong@agr.gc.ca; tel 613-759-1823; fax 613-759-1927

---

**Abstract.**—A lectotype male and three paralectotype females are designated for *Spalangia philippinensis* Fullaway, 1917, which is removed from synonymy with *S. endius* Walker, 1839, and placed in synonymy with *S. cameroni* Perkins, 1910, **syn. nov.** Two of the female paralectotypes are conspecific with *S. endius*, whereas the third is conspecific with *S. gemina* Bouček, 1963. The revised concept and new synonymy are based on comparison of the original description and illustrations of *S. philippinensis* with the four specimens that are interpreted as syntypes. The lectotype is selected so as to least disrupt current nomenclature while being compatible with the original description. Current concepts of *S. cameroni* and *S. simplex* Perkins, 1910, as interpreted by Bouček (1963), are confirmed by examination of type material of these species.

---

Fullaway (1917) described and illustrated both sexes of *Spalangia philippinensis* (Hymenoptera: Pteromalidae) from a culture that had been established in 1914 from house fly, *Musca domestica* L. (Diptera: Muscidae), puparia and other muscid puparia collected in the Philippines. The parasitoids were propagated and released in Hawaii as part of a control program for the horn fly, *Haematobia irritans* (L.) (Diptera: Muscidae). Fullaway briefly compared his new species to *S. cameroni* Perkins, 1910, but did not state the number of females and males he had before him, nor select a holotype or state where type material was deposited.

Bouček (1963) revised the world species of *Spalangia* Latreille. In this work he synonymized *S. philippinensis* under *S. endius* Walker, 1839, based on two females that Fullaway had sent him “of his species”, and newly described *S. gemina* based on females and males from Mauritius, India, Thailand, Malaysia, Fiji, and Venezuela. The name *S. philippinensis* has not been used in any scientific publication

since Bouček (1963) except as a synonym of *S. endius* or in simple lists of taxa. In contrast, extensive information has been published under the name *S. gemina*, including research on its life history (Morgan et al. 1989, 1991), biological attributes (Costa 1995; Geden 1999, 2002) and host-parasitoid modelling (Geden 1996, 1997). Several publications also compare it to other *Spalangia* species or list new distribution and host records (see Noyes 2003 for summary), and three partial sequences of the 12S and 28S ribosomal RNA genes have been deposited in GenBank under the name *S. gemina* (accession numbers AF289673, AY855200 and AY8500201).

As part of research investigating the identity and diversity of chalcid parasitoids of filth-breeding flies in North America, I borrowed type material of three species of *Spalangia* housed at the Bernice P. Bishop Museum, Honolulu, Hawaii (BPBM). The material included a single female syntype of *S. cameroni* (labelled as holotype no. 1578), a male and female syntype of *S. simplex* Perkins, 1910

(mounted together on one card and labelled as holotype no. 1579), and a female labelled "type" and a male labelled "type ♂" of *S. philippinensis*. The latter two specimens were mounted separately on square cards<sup>1</sup> and additionally bore three identical printed labels with "Honolulu H.T.", "D.T. Fullaway collector" and "Insectary".

Bouček examined the male type of *S. endius* in The Natural History Museum, London (BMNH), but he did not have the opportunity to examine type material of *S. cameroni*, *S. philippinensis* or *S. simplex*. My study of the type specimens of *S. cameroni* and *S. simplex* confirmed Bouček's (1963) interpretation of these two names. However, examination of the BPBM specimens labelled as type and male type of *S. philippinensis* revealed that the female is conspecific with *S. gemina* and the male is conspecific with *S. cameroni*. Following this discovery, I investigated whether collections of the Department of Entomology, University of Hawaii, Manoa (UHM) and the Hawaii Department of Agriculture, Division of Plant Industry, Honolulu (HDOA) possessed any other potential syntypes of *S. philippinensis*. The UHM collection contains no specimens identified as *S. philippinensis*, but I received three females labelled as *S. philippinensis* from HDOA. One of the HDOA females bears three labels with "Honolulu Oahu", "original cotype" and "Type material *Spalangia philippinensis*". The latter label is of the same red paper and *Spalangia philippinensis* is in the same handwriting as the type labels of the two BPBM specimens. The female is mounted upside down on a plastic point so that its propodeum is concealed, and it lacks its head and antennae, but sculpture of the pronotum indicates it is a *S. endius* female. The other two HDOA

females are also *S. endius*. One is point-mounted and bears three printed labels with almost the same data as the BPBM specimens, "Honolulu Oahu", "D.T. Fullaway collector", and "Insectary". The other female bears a single handwritten label with "Honolulu Oahu"; it is also point-mounted but has a minuten pin through the point that is pinned into a circular piece of paper pierced by a second, larger pin. Consequently, three specimens are labelled variously as "types" of *S. philippinensis* and these comprise three different species—*S. endius* Walker, *S. cameroni* Perkins, and *S. gemina* Bouček. I therefore studied the original description and illustrations in Fullaway (1917) (dorsal habitus of female *S. philippinensis* and female and male antenna of *S. philippinensis* and *S. cameroni*) in an attempt to determine which species, under current concepts, was described as *S. philippinensis*. The purpose of this paper is to select a lectotype for *S. philippinensis* that least affects stability of existing nomenclature while still being compatible with the original concept and description of Fullaway (1917).

## MATERIALS AND METHODS

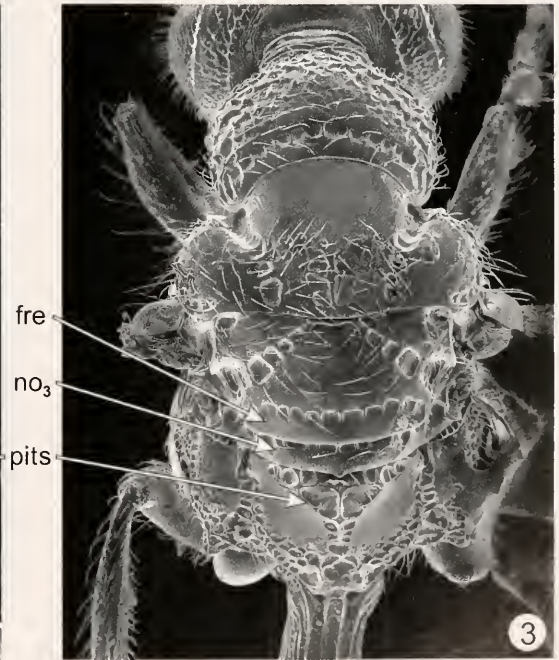
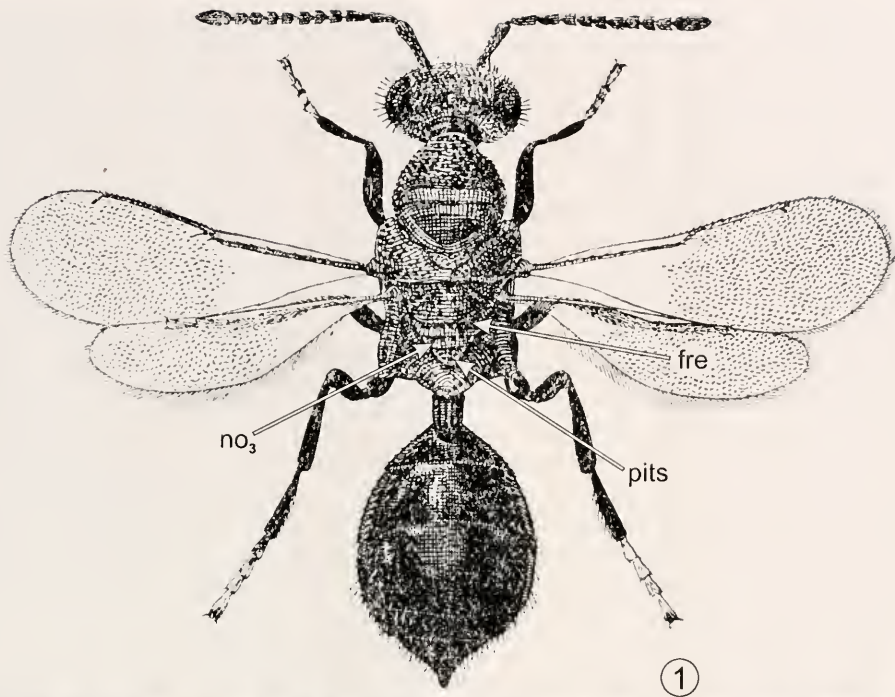
My concepts of *S. gemina* and *S. endius* are based on Bouček (1963). Terms for structure follow Gibson (1997). Relative measurements were taken with a Nikon SMZ-1500 microscope fitted with a 10 mm ocular grid having 100 divisions. Scanning electron photomicrographs of type-series specimens of *S. philippinensis* were taken using an environmental SEM and digitally retouched using Adobe Photoshop™ in order to enhance clarity.

## RESULTS

Gibson (2000) provided an illustrated key that differentiates *S. cameroni*, *S. gemina* and *S. endius* from other introduced and native species of *Spalangia* that are parasitoids of filth flies (Diptera: Muscidae) in North America. Features used to differen-

<sup>1</sup>The female was partly broken and detached from the card except by the apex of one fore wing when it arrived; I therefore point-mounted it and pinned below it the original card with pieces of the specimen still attached.





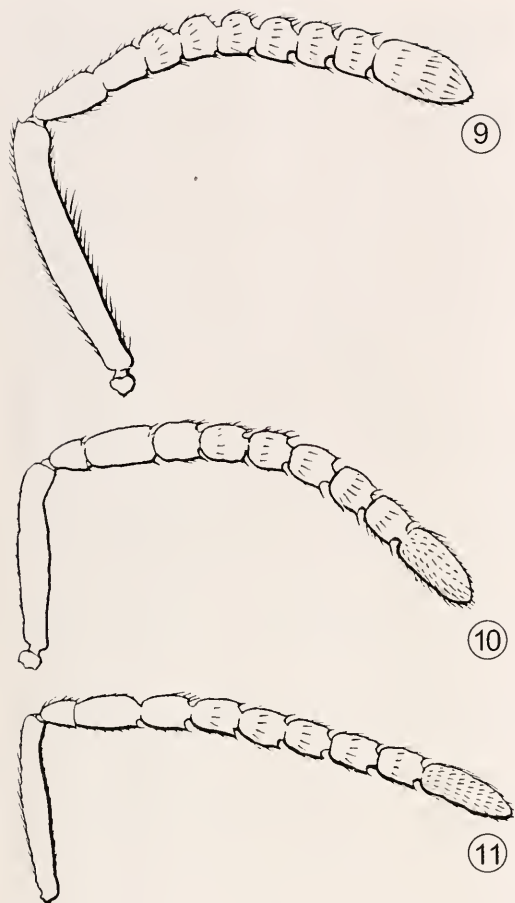
Figs 1–3. 1, *Spalangia philippinensis*, original habitus drawing adapted from Fullaway (1917). 2, *S. eudius*, dorsal mesosoma. 3, *S. philippinensis*, BPBM female paralectotype, dorsal mesosoma. (Abbreviations: fre = frenal line, no<sub>3</sub> = metanotum, pits = anterior cells of paramedian crenulate furrows.) Scale bar = 200  $\mu$ .

tiate *S. endius* from *S. cameroni* and *S. gemina* include differences in sculpture of the pronotum and propodeum, and a difference in the setal pattern of the fore wing of males. *Spalangia endius* has the pronotum comparatively sparsely punctate with circular depressions separated by flat, shiny interspaces (Fig. 2), whereas *S. cameroni* and *S. gemina* belong to a group of species that share a rugulose-reticulate pronotum, the depressions being so crowded as to be irregular (Fig. 3). There is also a conspicuous difference in propodeal sculpture between *S. endius* and the other two species. Although all three species have a transverse row of crenulae along the anterior margin of the propodeum (Figs 2, 3), in *S. endius* the paramedian crenulate furrows posterior to the transverse row of crenulations are parallel or only slightly and evenly widened anteriorly so as to form a narrowly V-shaped sculptural complex. Furthermore, the anterior most cells of the paramedian crenulate furrows are similar in size to the other cells of the furrows (Fig. 2). In contrast, both *S. cameroni* and *S. gemina* have the paramedian crenulate furrows obviously widened anteriorly so as to form more of a Y-like sculptural complex, with the anterior most cell or cells on either side of the median carina being conspicuously larger than the more posterior cells and usually also tapered posteriorly (Figs 3, 4). Based on these two features, both the original description and the female habitus illustration of *S. philippinensis* given by Fullaway (1917) (reproduced here as Fig. 1) demonstrate that the species could be *S. gemina* and/or *S. cameroni*, but not *S. endius*. Although the original female habitus illustration is not detailed, the pronotum is obviously coarsely sculptured (Fig. 1). Furthermore, the description of the female states "pronotum rugose and hairy", which accurately describes the pronotum of the BPBM female (Fig. 3) and male, but does not correctly describe the pronotum of any of the three HDOA females (Fig. 2).



Figs 4-8. 4, *Spalangia philippinensis*, male lectotype propodeum. 5-8 antenna. 5, *S. philippinensis*, BPBM female paralectotype (= *S. gemina*). 6, *S. philippinensis*, HDOA female paralectotype (= *S. endius*). 7, *S. philippinensis*, male lectotype (= *S. cameroni*). 8, *S. gemina*, male. Scale bar = 200  $\mu$ .





Figs 9–11. Line drawings of antennae reproduced from Fullaway (1917). 9, *Spalangia philippinensis* female. 10, *S. philippinensis* male. 11, *S. cameroni* male.

The female description also states “a longitudinal carina divides it [propodeum], in front passing between two rather large shallow pits and behind flanked on either side by a punctate line or furrow”. The female habitus clearly illustrates the described pits as a triangular region (Fig. 1, pits) posterior to the scutellar frenalum and metanotum (Fig. 1, fre, no<sub>3</sub>), similar to that of the BPBM female (Fig. 3) and male (Fig. 4) but not to the propodeal sculpture of the HDOA females (Fig. 2). Finally, although the fore wing is entirely bare within the basal one-third of both sexes of *S. gemina* and *S. cameroni*, males of *S. endius* have conspicuous setae within and de-

fining the basal cell (see figures in Gibson 2000). For *S. philippinensis* the female fore wing was described as “ciliate outwardly from the juncture of submarginal with marginal but basally bare” (Fig. 1). The male of *S. philippinensis* was described only relative to how it differed from the female and the description does not mention any difference in fore wing setation between the sexes; therefore, a basally bare fore wing must also be assumed for the male. This represents a third feature that indicates Fullaway was describing either *S. cameroni* or *S. gemina* but not *S. endius* as *S. philippinensis*.

In his key to species, Bouček (1963) differentiated *S. gemina* from *S. cameroni* based on slight differences in head shape and antennal structure. Females of *S. cameroni* were stated to have the second funicular segment oblong and the distal segments quadrate, whereas females of *S. gemina* were stated to have the second funicular segment subquadrate and the following segments transverse. The female description of *S. philippinensis* states “1st funicular joint about equal to pedicel, the next two joints about as broad as long, the four following ones a trifle wider than long”. This accurately describes the antenna of the BPBM female labelled as type (Fig. 5) and the female antenna Fullaway illustrated as *S. philippinensis* (reproduced here as Fig. 9), but conflicts with the antennal structure of female *S. endius*. Females of *S. endius* have the first funicular segment obviously shorter than the pedicel (Fig. 6), a fourth feature that suggests Fullaway’s concept of *S. philippinensis* was not in the sense of *S. endius*. Bouček (1963) further stated that males of *S. cameroni* have the distal funicular segments clearly oblong compared to hardly longer than broad for males of *S. gemina*. The male description of *S. philippinensis* states “the first funicle joint long ...and the other funicular segments all longer than wide”. The BPBM male syntype has all the funicular segments obviously oblong

(Fig. 7), which is more similar to the male antenna that Fullaway illustrated as *S. cameroni* (reproduced here as Fig. 11) than to the original illustration provided for the male of *S. philippinensis* (reproduced here as Fig. 10) or to the antenna characteristic of males of *S. gemina* (Fig. 8). Bouček (1963) also described a difference in genal length between females of *S. cameroni* and *S. gemina*. In *S. cameroni* females the gena was described as being slightly longer than the relatively small eyes, whereas in *S. gemina* it was said to be shorter than the width of the eye. This difference was restated by Gibson (2000), who also described males of *S. cameroni* as having the gena only slightly less than the width and at least two-thirds the length of an eye, in contrast to males of *S. gemina*, which have the gena distinctly less than the width and less than half the length of an eye. The original description of the male of *S. philippinensis* states that the head is shorter than for the female, but no mention is made of the length of the gena, which for the female is described as "cheeks flat and as long as the eyes". This latter statement suggests that a female of *S. cameroni* rather than *S. gemina* was being described as *S. philippinensis*, but it conflicts with the description and illustration of the female antenna and is the only statement in the female description that does not accurately reflect the BPBM female labelled as type. In this female, relative measurements of eye width: eye length: maximum genal length = 47 : 62 : 50. The same relative measurements for the BPBM male are 39 : 51 : 40.

## DISCUSSION

Multiple species of *Spalangia* are commonly reared as part of surveys of pupal parasitoids of filth-breeding flies. Sulaiman et al. (1990) reared *S. cameroni*, *S. endius* and *S. gemina* along with another species, *S. nigroaenea* Curtis, 1839, in a survey in peninsular Malaysia. Fullaway established his colony from the puparia of *Musca*

*domestica* as well as other muscid puparia collected in the Philippines. It is therefore quite likely that his colony, and the type series of *S. philippinensis* taken from it, was composed of more than one species. The BPBM female labelled as "type" and the male labelled as "type ♂" of *S. philippinensis*, which are also labelled "Insectary", show that the colony consisted of at least two species, *S. gemina* and *S. cameroni*, respectively. Under material examined for *S. endius*, Bouček (1963) listed the data "Hawaii: Philippine *Spalangia*" for the two females that Fullaway sent to him as his species. Consequently, the specimens may have been adults collected in the Philippines rather than cultured specimens and if so are not part of the original type series and therefore ineligible for lectotype designation. However, the HDOA female labelled as "original cotype" and with a red type label similar to the BPBM specimens is *S. endius*, and because of its labels I accept it as a third syntype of *S. philippinensis*. I also interpret as a syntype the HDOA female with almost the same labels and data as the BPBM specimens. I exclude from the type series the HDOA female that has only a single handwritten label because there is no indication that it was a Fullaway specimen or that it originated from the insectary. Regardless, the four remaining specimens I interpret as syntypes indicate that the colony from which *S. philippinensis* was described consisted of at least *S. cameroni*, *S. gemina* and *S. endius*. Therefore, designation of a lectotype is necessary to fix the meaning of *S. philippinensis*.

The current International Code of Zoological Nomenclature (ICZN 1999) recommends that to preserve stability of nomenclature an author should act consistently with or at least give great weight to previously accepted taxonomic restrictions of the application of the name when designating a lectotype (recommendation 74A). For *S. philippinensis*, such stability could be achieved by designating one of the two HDOA syntype females as lecto-



type, which would retain Bouček's (1963) synonymy of *S. philippinensis* under *S. endius*. However, fixation of the name in the sense of *S. endius* would be demonstrably incorrect based on the original description and illustrations of *S. philippinensis* provided by Fullaway (1917). I consider such an obviously incorrect nomenclatural action as inappropriate, even though Fullaway also misinterpreted his species many years after the original description when he sent specimens to Bouček. The original description and illustrations clearly demonstrate that one or both of *S. cameroni* and *S. gemina* were described as *S. philippinensis*. Fullaway's brief comparison of his new species with *S. cameroni* demonstrates that he was aware of the latter species and considered that it was distinct, but it is unclear whether the differential features he gave (stouter antenna with first funicle joint more or less obconic, and shorter club) referred to the female of *S. philippinensis* only. There are also discrepancies in the descriptions and illustrations that suggest these might have been from a mixed series of *S. cameroni* and *S. gemina*. The description of the female antenna matches that of *S. gemina* and the BPBM female labelled as type, whereas the description of the cheeks suggests a female of *S. cameroni* was being described. The illustration of the male antenna of *S. philippinensis* (Fig. 10) is certainly more characteristic of *S. gemina* (Fig. 8) than *S. cameroni* (Fig. 7), but the corresponding description states that the funicular segments beyond the first segment are all "longer than wide", which is characteristic of *S. cameroni* and certainly descriptive of the antenna of the BPBM specimen labelled as male type of the species (Fig. 7). There is no information in the original publication concerning whether the illustrations were prepared from the actual specimens used by Fullaway to prepare the descriptions, or from other colony specimens, and it is certain that the colony consisted of a mixed culture. The original description and illus-

trations clearly demonstrate that *S. philippinensis* was established in the sense of *S. gemina* or *S. cameroni*, but it can not be stated unequivocally that it was in the current sense of only one of these two names. Although the description of the female is the primary description for the species and the BPBM female is labelled as "type", no holotype was selected in the original description. I therefore designate the BPBM male, labelled as "type ♂, *Spalangia philippinensis*", as lectotype of *S. philippinensis*. I designate the corresponding BPBM female and the two HDOA females discussed above as paralectotypes and have added my lectotype and paralectotype labels to the respective specimens. The selection of the BPBM male as lectotype is at least compatible with the original description of *S. philippinensis*. It also minimizes disruption of current nomenclature because it retains the name as a junior synonym and avoids the synonymy of *S. gemina* Bouček, a name with an extensive modern literature, which would result if the BPBM female was selected as lectotype of the species. I therefore remove *S. philippinensis* Fullaway, 1917, from synonymy with *S. endius* Walker, 1839, and newly synonymize the name with *S. cameroni* Perkins, 1910, **syn. nov.**

#### ACKNOWLEDGEMENTS

I thank Dr Gordon Nishida for the extended loan of the BPBM *Spalangia* type material, Dr Bernarr Kumashiro for the HDOA specimens, and Dr Dick Tsuda for information concerning the UHM collection. I also thank Ms Jennifer Read (AAFC, Ottawa) for the scanning electron micrographs and reproduction of Fullaway's illustrations, and Dr John Huber (Canadian Forest Service, Ottawa) and Dr James O'Hara (AAFC, Ottawa) for reviewing and providing constructive criticism of an earlier version of this manuscript.

#### LITERATURE CITED

- Bouček, Z. 1963. A taxonomic study in *Spalangia* Latr. (Hymenoptera, Chalcidoidea). *Acta Entomologica Musei Nationalis Pragae* 35: 429–512.
- Costa, V. A. 1995. Efeito da temperatura na biologia de *Spalangia gemina* Bouček, 1963 (Hymenoptera: Pter-

- omalidae) parasitoide pupal de *Musca domestica* L., 1758 (Diptera: Muscidae). Tese de doutorado, ESALQ-USP, Piracicaba, Brazil.
- Curtis, J. 1839. *British entomology, being illustrations and descriptions of the genera of insects found in Great Britain and Ireland*. Vol XVI, London.
- Fullaway, D. T. 1917. Description of a new species of *Spalangia*. *Proceedings of the Hawaiian Entomological Society* 3: 292–294.
- Geden, C. J. 1996. Modelling host attacks and progeny production of *Spalangia gemina*, *Spalangia cameroni*, and *Muscidifurax raptor* (Hymenoptera: Pteromalidae) at constant and variable temperatures. *Biological Control* 7: 172–178.
- Geden, C. J. 1997. Development models for the filth fly parasitoids *Spalangia gemina*, *S. cameroni*, and *Muscidifurax raptor* (Hymenoptera: Pteromalidae) under constant and variable temperatures. *Biological Control* 9: 185–192.
- Geden, C. J. 1999. Host location by house fly (Diptera: Muscidae) parasitoids in poultry manure at different moisture levels and host densities. *Environmental Entomology* 28: 755–760.
- Geden, C. J. 2002. Effect of habitat depth on host location by five species of parasitoids (Hymenoptera: Pteromalidae, Chalcididae) of house flies (Diptera: Muscidae) in three types of substrates. *Environmental Entomology* 31: 411–417.
- Gibson, G. A. P. 1997. Chapter 2. Morphology and terminology. Pp. 16–44 in: Gibson, G. A. P., J. T. Huber, and J. B. Woolley, eds. *Annotated keys to the genera of Nearctic Chalcidoidea* (Hymenoptera). NRC Research Press, Ottawa.
- Gibson, G. A. P. 2000. *Illustrated key to the native and introduced chalcidoid parasitoids of filth flies in America north of Mexico* (Hymenoptera: Chalcidoidea). Available from <http://canacoll.org/Hym/Staff/Gibson/chalkey.pdf> [cited 20 April 2005].
- ICZN. 1999. *International Code of Zoological Nomenclature*. Fourth edition. International Trust for Zoological Nomenclature, London.
- Morgan, P. B., H. Hoyer, and R. S. Patterson. 1989. Life history of *Spalangia cameroni* (Hymenoptera: Pteromalidae), a microhymenopteran pupal parasite of muscoid flies (Diptera: Muscidae). *Journal of the Kansas Entomological Society* 62: 381–386.
- Morgan, P. B., E. Berti-Filho, and V. A. Costa. 1991. Life history of *Spalangia gemina* Boucek (Hymenoptera: Pteromalidae), a fast-breeding microhymenopteran pupal parasitoid of muscoid flies. *Medical and Veterinary Entomology* 5: 277–281.
- Noyes, J. S. 2003. *Universal Chalcidoidea database*. Available from <http://www.nhm.ac.uk/entomology/chalcidoids> [cited 20 April 2005].
- Perkins, R. C. L. 1910. Supplement to Hymenoptera. Pp. 600–686 in: *Fauna Hawaiiensis*. London, England.
- Sulaiman, S., B. Omar, S. Omar, J. Jeffery, I. Ghauth, and V. Busparani. 1990. Survey of microhymenoptera (Hymenoptera: Chalcidoidea) parasitizing filth flies (Diptera: Muscidae, Calliphoridae) breeding in refuse and poultry farms in peninsular Malaysia. *Journal of Medical Entomology* 27: 851–855.
- Walker, F. 1839. *Monographia Chalciditum*. 2. London.

## Phylogeny and Checklist of the Nocturnal Tiphids of the Western Hemisphere (Hymenoptera: Tiphidae: Brachycistidinae)

LYNN S. KIMSEY AND MARIUS S. WASBAUER

Bohart Museum of Entomology, Department of Entomology, University of California, One Shields Ave., Davis, CA, USA 95616, email: lskimsey@ucdavis.edu

---

**Abstract.**—Phylogenetic relationships among eleven genera of Brachycistidinae (Tiphidae) are discussed, based on male characteristics, and a key to the genera is provided. The genus *Stilbopogon* is found to be the sister group of the rest of the brachycistidine genera. There are two well supported clades: *Brachymaya* + (*Hadrocistis* + *Brachycistina*) and (*Paraquemaya* + (*Brachycistellus* + (*Dolichetropis* + (*Sedomaya* + (*Brachycistis* + (*Acanthetropis* + *Colocistis*)))))). A complete synonymic checklist of genera and species is also given, with **new synonymy** of the Cameron species *Brachycistis tysias*, *Brachycistis dubitatus* and *Brachycistis sciron* under *Brachycistis alcanor* (Blake), and *Brachycistis fulvilabris* and *Brachycistis arines* under *Brachycistis vigilax* Cameron. In addition, *Brachycistis ioachinensis* Bradley is also **newly synonymized under vigilax**.

**Key words.**—Tiphidae, Brachycistidinae, *Acanthetropis*, *Brachymaya*, *Brachycistis*, *Brachycistellus*, *Colocistis*, *Dolichetropis*, *Hadrocistis*, *Paraquemaya*, *Sedomaya*, *Stilbopogon*

---

Nocturnal tiphids in the Western Hemisphere all belong to the subfamily Brachycistidinae, which only occurs in the Americas. In the Palearctic and Afrotropical Regions nocturnal tiphids are all members of the subfamily Myzininae. There has never been a monographic review of the Brachycistidinae, although a number of the genera have been at least partly revised (Kimsey and Wasbauer 1998a, 1998b, Wasbauer 1958, 1966, 1968a). Brothers (1975), Brothers and Carpenter (1993) and Kimsey (1991) gave Brachycistidinae status as the sister group of Tiphinae. This monophyletic group is characterized by a number of distinctive modifications, including in the male the pronotum lacking a dorsal surface, edentate tarsal claws, ocelli generally enlarged, and forewing with abbreviated marginal and submedial cells, and in the female a single midtibial spur.

Brachycistidine wasps are thought to be difficult taxonomically because they lack distinctive coloration and the species appear structurally similar. However, the

males have distinctive and informative modifications of the head, thorax, wing venation and genitalia. Most of the taxonomy of Brachycistidinae is based on males. Some aspects of the wing venation used to discriminate species and genera, such as the number of submarginal or discoidal cells, seem correlated with body size rather than higher taxon. The greatest taxonomic problem in this group is one shared by the Mutillidae: males and females are adapted for entirely different microhabitats and share few if any characteristics. Females are wingless and ant-like, lacking even ocelli. There are very few female brachycistidines in collections, as they are nocturnal and are not collected by common trapping methods. In Brachycistidinae this dichotomy has resulted in entirely different species and generic level nomenclature for males versus females. Mickel and Krombein (1942) described seven genera on the basis of females and there are currently 11 genera based on males. Wasbauer (1968b, 1971) associated some of the



Table 1. Character matrix for the brachycistidine genera based on male characteristics discussed in the text.

										<u>1</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>2</u>	<u>2</u>	<u>2</u>	<u>2</u>	<u>2</u>	
	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4
<i>Tiphia</i>	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
<i>Stilbopogon</i>	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0
<i>Brachymaya</i>	1	0	1	0	0	0	0	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	1	1
<i>Hadrocistis</i>	1	0	1	1	1	0	0	0	1	1	0	0	0	0	0	1	1	0	0	0	0	1	1	1
<i>Brachycistina</i>	1	0	1	1	1	0	0	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	1	0
<i>Acanthetropis</i>	1	1	2	0	0	1	1	1	1	1	1	1	1	1	1	2	0	0	0	1	1	0	1	0
<i>Colocistis</i>	1	1	2	0	0	1	1	1	1	1	1	0	1	1	1	2	0	1	0	1	0	0	0	0
<i>Brachycistis</i>	1	1	2	0	0	1	1	1	1	1	1	0	0	1	0	2	0	0	0	0	0	0	1	1
<i>Brachycistellus</i>	1	0	1	0	0	1	0	0	1	1	1	0	0	0	0	2	0	0	0	1	0	0	1	0
<i>Dolichetropis</i>	1	1	1	0	0	1	0	0	1	1	1	0	0	0	0	1	0	0	0	0	0	0	1	1
<i>Paraquemaya</i>	1	0	1	0	0	1	0	0	1	1	0	0	0	0	0	1	0	0	0	1	0	0	1	1
<i>Sedomaya</i>	1	1	1	0	0	1	0	1	1	1	1	0	0	0	0	1	0	0	0	1	0	0	1	1

type species of these female-based genera with males in the genus *Brachycistis*. Additional synonymies were made by Kimsey (2006). Clearly, more sex associations may be needed to eliminate extraneous generic and species names in this group, but this can probably only be accomplished by more intensive collecting efforts, DNA homologies, or by rearing once hosts are known. A complete synonymic checklist of the Brachycistidinae is given below.

MATERIALS AND METHODS

Specimens used in this study came from the Bohart Museum of Entomology, University of California, Davis (UCDC); Entomology Research Museum, University of California, Riverside (UCRC); the California Academy of Sciences, San Francisco (CAS), and the personal collection of M. S. Wasbauer. The species examined for this study are indicated in the checklist by an asterisk (\*). Collection repositories cited in the checklist include: MCZ - Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts (S. Shaw); CU - Department of Entomology, Cornell University, Ithaca, New York (J. Liebherr); SMEK - Snow Entomological Museum, University of Kansas, Lawrence (R. Brooks); EMUS - Entomology Collection, Utah State University, Logan (T. Gris-

wold); BMNH - The Natural History Museum, London, S. Lewis; LACM - Los Angeles County Museum of Natural History, Los Angeles, California (R. R. Snelling); AMNH - American Museum of Natural History, New York City, New York (J. M. Carpenter); ANSP - Philadelphia Academy of Sciences (D. Azuma); CAS - California Academy of Sciences, San Francisco (N. Penny); UMSP - University of Minnesota, St. Paul (J. C. Luhman); and NMNH - U. S. National Museum of Natural History, Smithsonian Institution, Washington, D. C. (A. S. Menke, K. V. Krombein). The Cameron *Brachycistis* types were borrowed from the Natural History Museum, London.

Male characters below were prepared using Winclada version 1.00.08 (Nixon 2002) and analyzed in Hennig86 (Farris 1988) and NONA version 2.0 (Goloboff 1999). The data matrix consisted of twenty-three male characters and 13 taxa (Table 1). The genus *Tiphia* was used to represent the sister group Tiphinae as the outgroup. Species used in the analysis were selected to give the widest range of characteristics possible. However, once characters were coded it was found that multiple species from each genus were redundant and were therefore eliminated from the analysis as uninformative, resulting in a single exemplar species for each genus.



*Characters.*—

1. Antennal socket: rim simple (0), with ventral carinule or dilation (1). In the majority of tithiids the antennal sockets are rimmed by a simple carina. This is also the case in *Stilbopogon* (Fig. 11). Therefore a simple antennal socket carina is considered primitive. In the other brachycistidine genera the socket carina has a ventrally pointing "tail", dilation or subsidiary carinule (Fig. 7).
2. Eye margin: flattened or evenly convex (0), emarginated (1). In *Tiphia* and the majority of brachycistidine genera the inner margin of male eye is flattened or convex. The remaining brachycistidine genera have the inner eye margin indented or emarginate (as in Fig. 7).
3. Clypeal shape: flat in profile (0), convex (1) or concave (2). In tithiines the male clypeus is flat in profile. In the majority of brachycistidines the clypeus is convex and in *Acanthetropis*, *Brachycistis* and *Colocistis* the clypeus is concave in profile.
4. Maxillary palpal segments: normal (0), reduced (1). The normal number of maxillary palpal segments in tithiids is six. In *Hadrocistis* the maxillary palp is polymorphic: 3 (*slanskyae*) or 5-segmented (*bicolor*). In *Brachycistina* the maxillary palp is 3-segmented.
5. Labial palpal segments normal (0), reduced (1). The normal number of labial palpal segments in tithiids is four. In *Hadrocistis* the labial palp is polymorphic: 1-segmented in *slanskyae* and 2-segmented in *bicolor*. In *Brachycistina* the labial palp is 1-segmented.
6. Mandibular carina: absent (0), present (1). In the primitive form of the mandible, there are no external carinae, angles or projections (as in Fig. 11). In many brachycistidines the mandible has a longitudinal ridge on the outer surface extending from near the base to a subapical position (as in Fig. 2).
7. Frons: smooth above each antennal socket (0), with arcuate carina and apical warts (1). A peculiar modification of the frons can be seen in *Brachycistis*, *Acanthetropis* and *Colocistis* (Figs 2, 4, 7). In these genera there is a short crescentic carina above each antennal socket. In most the carina terminates on either end in a small wart or tubercle. This is a feature found only in this clade.
8. Hypostomal carina. Carina ending at or outside mandibular socket (0), ending inside mandibular socket (1). In the majority of brachycistines and in *Tiphia* the hypostomal carina terminates midway on or outside of the mandibular socket. The carina ends inside the mandibular socket in *Sedomaya*, *Brachycistis*, *Acanthetropis* and *Colocistis*.
9. Gular bridge: simple (0), with narrow expansion over base of tongue (1). Unlike the condition seen in tithiines, in some brachycistidines the gula has a narrow expansion made up of a broadened hypostomal carina that overlaps the base of the tongue.
10. Pronotal dorsal surface: present (0), absent (1). In *Tiphia* and *Stilbopogon* the pronotum is dorsally expanded and the dorsal edge is planar with the scutum. In the rest of the Brachycistidinae, with the exception of two species of *Colocistis*, the pronotum lacks a dorsal surface and is substantially shorter than the strongly bulging scutum.
11. Stridulatory patch: absent (0), present (1). Most tithiids lack any kind of stridulatory structure. However in the majority of brachycistidine genera males have a small stridulatory structure on the mesal surface of the forecoxa, consisting of a defined, slightly raised patch of dense fine ridges (Fig. 27). This feature occurs in

- both major brachycistidine clades with a few notable, perhaps secondary, absences in *Brachycistina* and *Paraquemaya*.
12. Scrobal sulcus: absent (0), present (1). In brachycistidines a scrobal sulcus is only present in *Acanthetropis*.
  13. Hindwing discoidal veinlet: present (0), absent (1). All of the brachycistidine genera, except *Acanthetropis* and *Colocistis*, have a short discoidal veinlet present on the hindwing.
  14. Propodeal transverse carina: absent (0), present (1). A transverse carina dividing the dorsal from the posterior surfaces of the propodeum is seen only in *Acanthetropis*, *Colocistis* and *Brachycistis*.
  15. Propodeum dorsomedially: convex (0), longitudinally grooved (1). Another modification of the propodeum is the presence of a broad longitudinal groove extending posteriorly from the scutellar margin along the dorsal surface of the propodeum. This feature occurs in *Colocistis* and *Acanthetropis*.
  16. Metapleural lobes: fused (0), digitate (1) or broadly rounded (2). Tiphiiines have the metapleural lobes fused into a platform between the midcoxae. In the Brachycistidinae the metapleural lobes are either small and slender or flattened and apically rounded.
  17. Hindcoxal dorsal carina: present (0), absent (1). Throughout the Tiphiiidae the hindcoxa normally has a dorsal carina that extends from the coxal base towards the apex. This carina is absent in *Brachymaya*, *Hadrocistis* and *Brachycistina*.
  18. Hindcoxal ventromedial carina: absent (0), present (1). This is a unique feature in *Colocistis*.
  19. Basal petiolar carina: present (0), absent (1). In the Tiphiiinae, and most genera of Brachycistidinae the basal metasomal tergum has a strongly expanded lateral carina often completely ringing the tergum, which may serve to protect the petiolar socket. In *Stilbopogon* this carina is absent and the tergal base is simple where it inserts into the petiolar socket.
  20. Sternum I basal longitudinal carina present (0), absent (1). Tiphiiines have a short longitudinal carina extending down the middle of the basal gastral sternum from the base of the plate. This condition is also seen in *Acanthetropis*, *Brachycistellus* and *Colocistis* (Figs 28, 30). In the derived condition the first gastral sternum is smooth basally with no trace of a carina (Fig. 29).
  21. Sternum II: simple (0), with medial keel (1). The second gastral sternum is generally unmodified, although *Dolichetropis* have a transverse submedial carina. All species of *Acanthetropis* have a longitudinal keel or fold extending longitudinally from the base. In most *Acanthetropis* species this structure consists of a sharp posteriorly hooked, keel-like carina in the middle of this sternum. However, in *A. lamellatus* this structure consists of a longitudinal fold ending in a transverse lamella.
  22. Epipygium shape: rounded laterally (0), laterally carinate or folded (1). The epipygium, or apical metasomal tergum, is generally narrowed and evenly rounded apically in the Tiphiiidae. In brachycistidines the epipygium can be sharply folded or carinate laterally.
  23. Digitus apex: broadly rounded (0), apically elongate and acute (1). In tiphiiines the volsella is typically fist-shaped, with the digitus and cuspis forming short rounded apical lobes (Figs 32, 35, 41, 46). However, in the majority of brachycistidine genera the digitus is greatly elongate and digitate, or awl-shaped, extending apically (as in Figs 36, 37).
  24. Volsellar inner margin: smooth (0), denticulate (1). *Brachymaya*, *Hadrocistis*, *Brachycistis*, *Dolichetropis*, *Paraquemaya* and *Sedomaya* the inner margin of

the volsella is denticulate (as in Figs 36, 38). This surface is smooth in the remaining genera and in *Tiplia*.

RESULTS

*Phylogenetic analyses.*—Phylogenetic analysis of the matrix yielded a single optimal tree (Fig. 1A), with a tree length of 32, CI of 78 and RI of 83. Multistate characters were treated as non-additive and were equally weighted. Of these six proved uninformative as they coded for a single genus. Other characters used in the key, such as the orientation of the hindwing tCu vein and length of the forewing R vein, were eliminated from consideration early on because they only coded for a single genus. Bootstrap values were

calculated after eliminating suboptimal trees, resulting in the single tree in Fig. 1B. The values show strong to moderate support for most of the branches. *Stilbopogon* was found to be the basal taxon in the subfamily in all analyses. The rest of the genera fell into two well supported clades. One clade consisting of *Brachymaya*, *Hadrocistis* and *Brachycistina*, based on the lack of a dorsal coxal carina. The second clade contains the remaining genera, based on the presence of a mandibular carina and a T-shaped carina at the base of metasomal sternum I. The resulting generic relationships are *Stilbopogon* + (*Brachymaya* + (*Hadrocistis* + *Brachycistina*)) + (*Paraquemaya* + (*Brachycistellus* + (*Dolichetropis* + (*Sedomaya* + (*Brachycistis* + (*Acanthetropis* + *Colocistis*)))))).

KEY TO MALES OF THE GENERA OF BRACHYCISTIDINAE

- 1 Forewing with two discoidal cells (as in Fig. 14) ..... 2
- Forewing with one discoidal cell (as in Fig. 15) ..... 6
  
- 2 Sternum II with medial longitudinal ridge or keel extending posteriorly from base; forewing R vein extending along costal margin more than two-thirds length of stigma (Fig. 14) ..... *Acanthetropis* Wasbauer
- Sternum II without medial ridge; forewing R vein extending along costal margin for less than two-thirds the length of stigma or not reaching costal margin at all (as in Figs 15, 17) ..... 3
  
- 3 Mandible without longitudinal carina on external surface and with two apical teeth (Fig. 5); maxillary and labial palpi highly reduced barely visible between mandibles, with three and two or fewer palpomeres respectively ..... *Brachycistina* Malloch
- Mandible with longitudinal carina on external surface and with three apical teeth (as in Fig. 4); maxillary and labial palpi clearly visible beneath head, extending as far as occipital carina or further, with six and four palpomeres respectively ..... 4
  
- 4 Maxillary palpi slender and short, barely reaching occipital carina; forewing R vein extending along costal margin between one half and two-thirds stigmal length (Fig. 20) ..... *Dolichetropis* Wasbauer
- Maxillary palpi robust and long, extending well beyond underside of head; forewing R vein extending along costal margin less than one-third stigmal length or not even reaching costal margin ..... 5
  
- 5 Sternum I with short medial longitudinal carina extending posteriorly from base; forewing tCu-1 arising at or before basal third of first submarginal cell (Fig. 19); digitus with short, broadly rounded apex (Figs 39, 40) ..... *Colocistis* Krombein
- Sternum I smooth subbasally without medial carina; forewing tCu-I arising beyond basal third of first submarginal cell (Fig. 17); digitus with elongate, acute apex (Figs 36, 37) ..... *Brachycistis* Fox

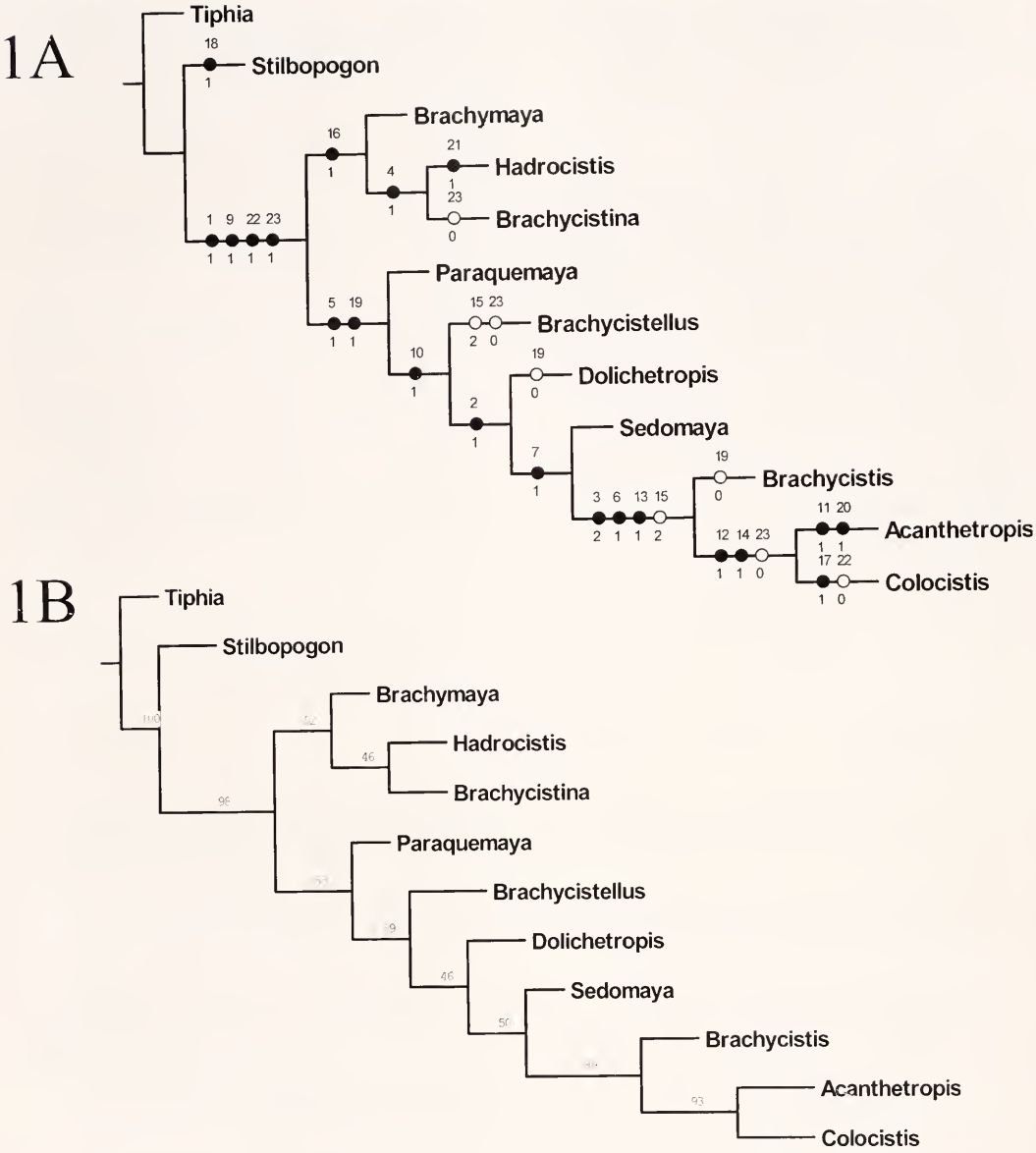
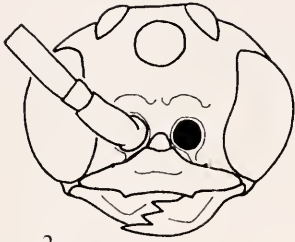


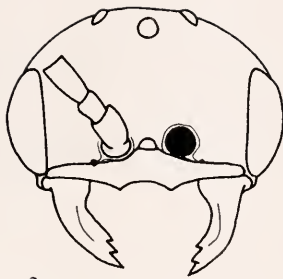
Fig. 1. Cladograms of relationships among the ten genera of Brachycistidinae based on male characteristics. Fig. 1A. Tree showing relationships among the genera. Numbers refer to characteristics discussed in the text. Fig. 1B. Tree showing Bootstrap values.

- 6 Hindwing cubitus forming a nearly straight line with transverse cubitus, meeting it at more 130° angle or greater (Fig. 23); digitus short, blunt, without elongate apex (Figs 45, 46) ..... *Stilbopogon* Mickel and Krombein
- Hindwing cubitus arcuately curved, meeting transverse cubitus at less than 130° angle; digitus usually with elongate, acute apex ..... 7

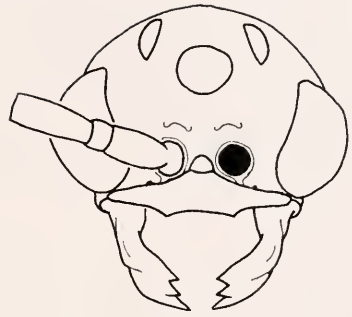




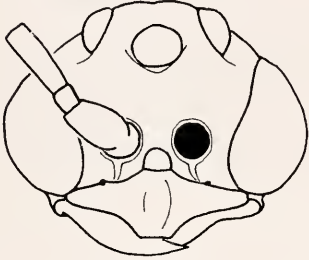
2. *Acanthetropis aequalis*



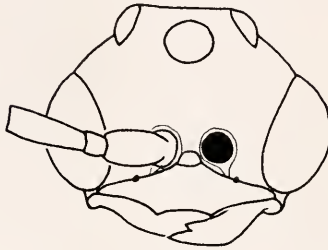
3. *Brachycistellus figitiformis*



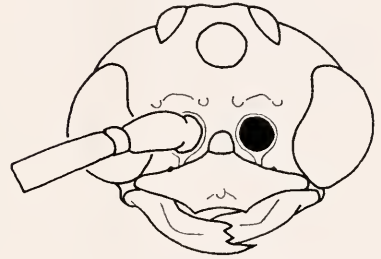
4. *Brachycistis alcanor*



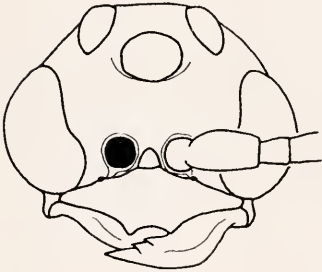
5. *Brachycistina acuta*



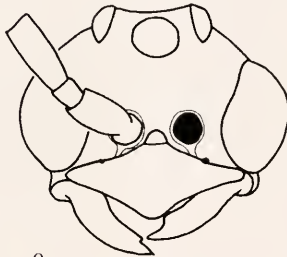
6. *Brachymaya mexicana*



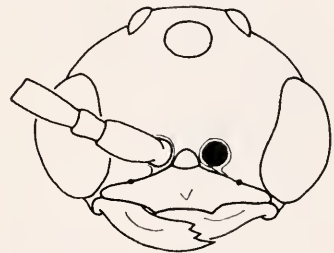
7. *Colocistis crassa*



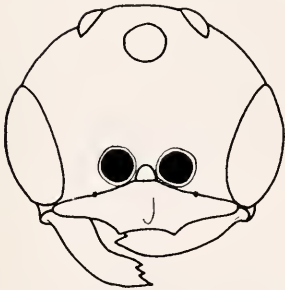
8. *Dolichetropis flavida*



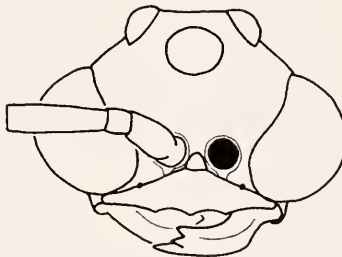
9. *Hadrocistis slanskyae*



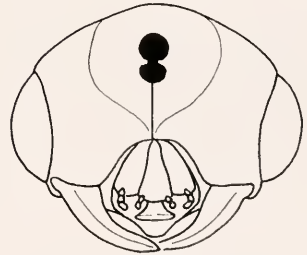
10. *Paraquemaya pallida*



11. *Quemaya marcida*

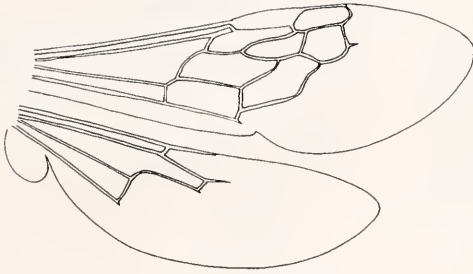
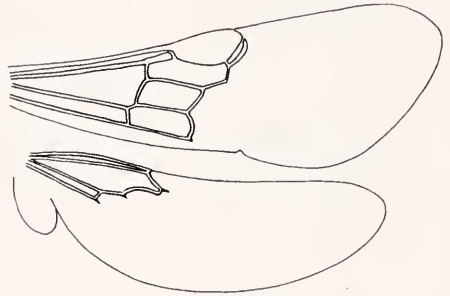
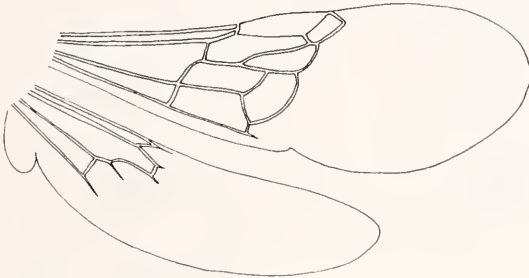
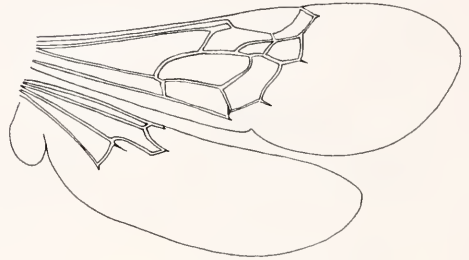
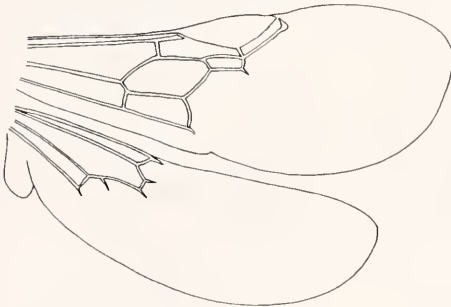
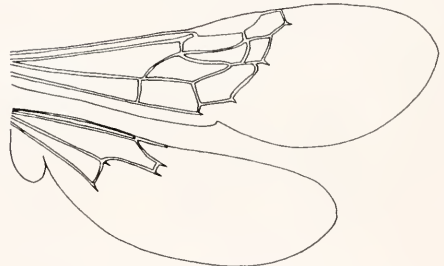
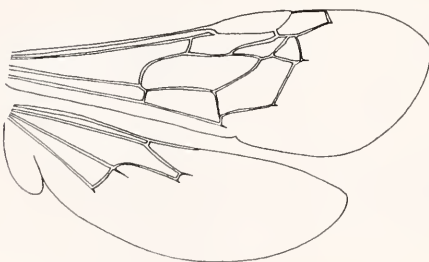
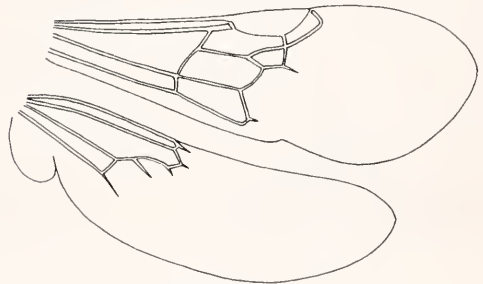


12. *Sedomaya glamisensis*

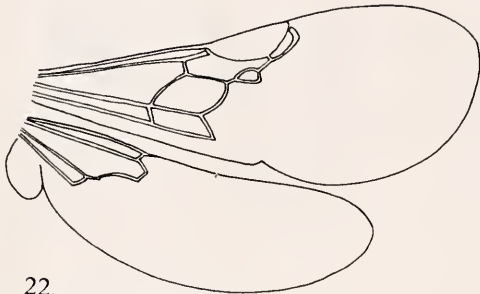


13. *Hadrocistis slanskyae*

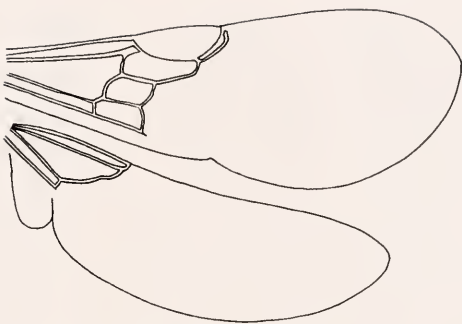
Figs 2–13. Male head, with one or both antennae removed. Figs 2–12. Front view. Fig. 13. Ventral view.

14. *Acanthetropis aequalis*15. *Brachycistellus figitiformis*16. *Brachycistina acuta*17. *Brachycistis alcanor*18. *Brachymaya mexicana*19. *Colocistis stygia*20. *Dolichetropis flavida*21. *Hadrocistis slanskyae*

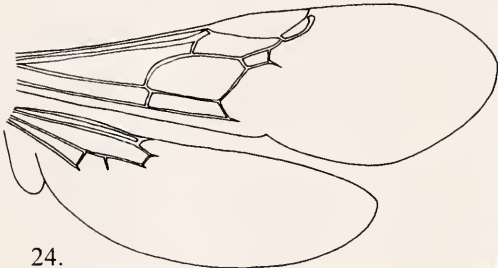
Figs 14-21. Male fore and hindwings.



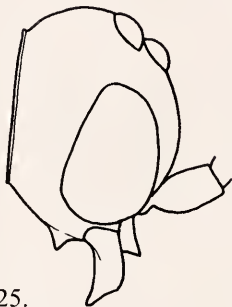
22.  
*Paraquemaya bitincta*



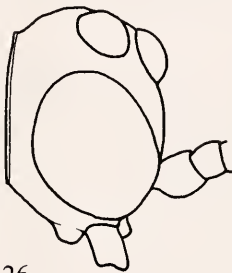
23. *Quemaya marcida*



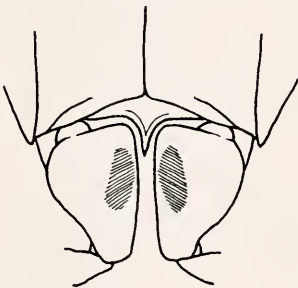
24.  
*Sedomaya glamisensis*



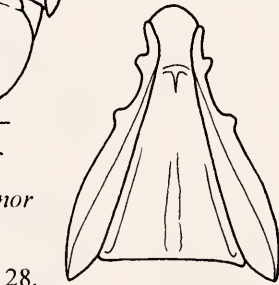
25.  
*Paraquemaya pallida*



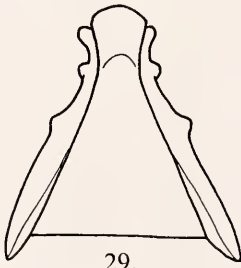
26.  
*Sedomaya glamisensis*



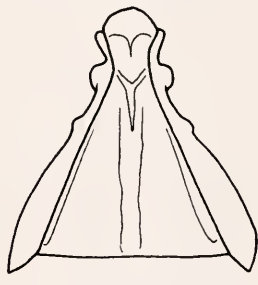
27.  
*Brachycistis alcanor*



28.  
*Acanthetropis lamellatus*



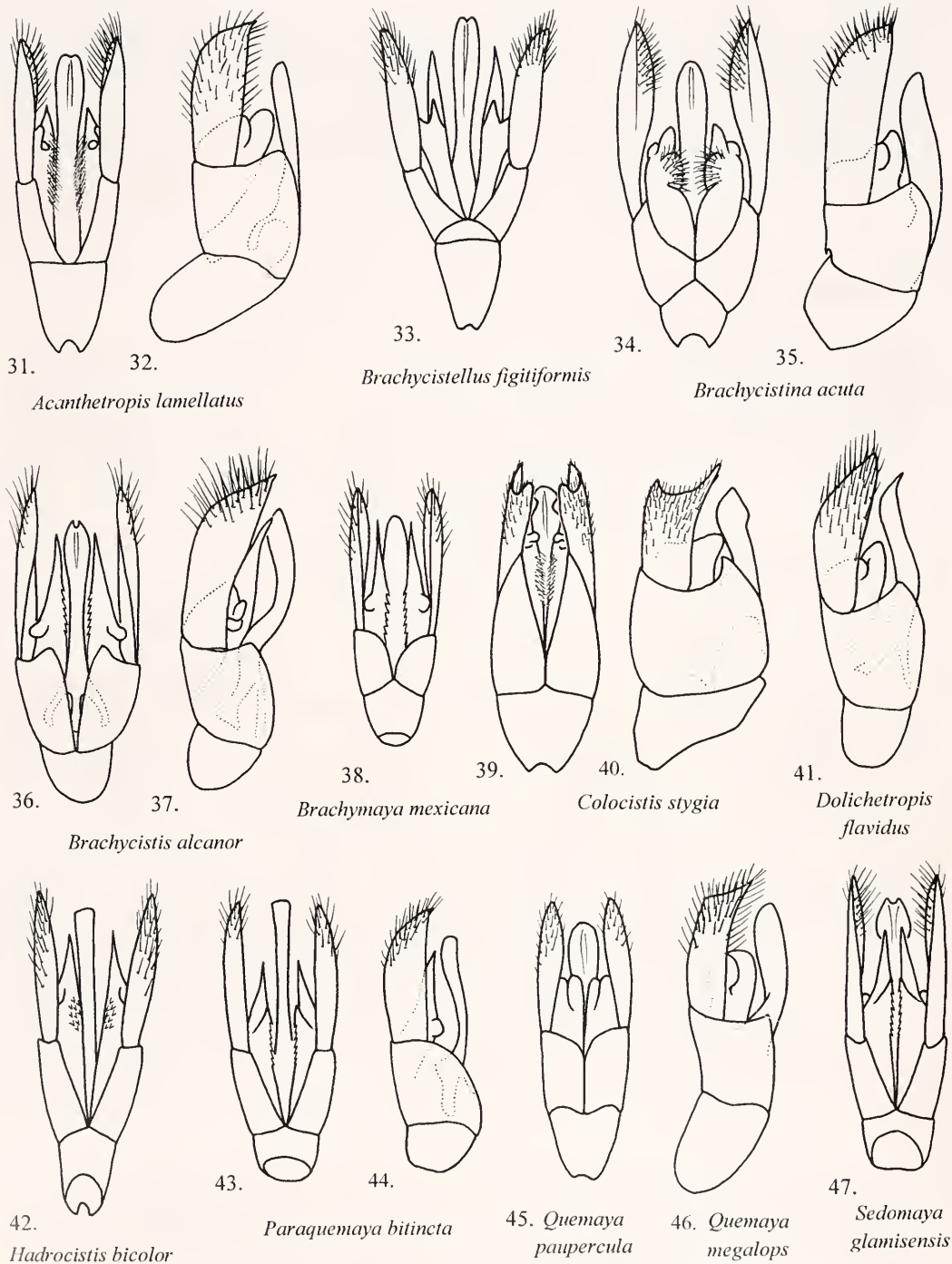
29.  
*Dolichetropis flavida*



30. *Colocistis stygia*

Figs 22–24. Male fore and hindwings. Figs 25, 26. Lateral view of male head. Fig. 27. Ventral view of prothorax and forecoxae. Figs 28–30. Ventral view of basal gastral sternum.

- 7 Palpi highly reduced, shorter than oral fossa, with fewer than five maxillary and three labial palpomeres (Fig. 13) ..... *Hadrocistis* Wasbauer
- Palpi large, much longer than oral cavity; with six maxillary and four labial palpomeres 8
- 8 Propodeum heavily sculptured with transverse carina separating dorsal and posterior surfaces; compound eyes and ocelli not enlarged, distance between midocellus and nearest eye margin 4–5 MOD (Fig. 3) ..... *Brachycistellus* Baker
- Propodeum nearly smooth, without transverse carina; compound eyes and ocelli enlarged, distance between midocellus and nearest eye margin not more than 3 MOD ..... 9



Figs 31-47. Male genital capsule. Figs 31, 33, 34, 36, 38, 39, 42, 43, 45, 47. Ventral view. Figs 32, 35, 37, 40, 44, 46. Lateral view.



- 9 Mandible bidentate, without longitudinal carina on external surface (Fig. 6); oral carina simple and gular area at base of mandible (traversed by oral carina) not dilated or bulging ..... *Brachyuuya* Kimsey and Wasbauer
- Mandible tridentate, with longitudinal carina on external surface; oral carina expanded into tooth or lamella (Fig. 25) or gular area (traversed by oral carina) bulging near base of mandible (Fig. 26) ..... 10
- 10 Oral carina expanded into lamellate projection or tooth near mandibular base, gular area not bulging near base of mandible (Fig. 25); forecoxa without stridulatory patch on mesal surface ..... *Paraquemaya* Kimsey and Wasbauer
- Oral carina unmodified, gular area strongly bulging near base of mandible (Fig. 26); forecoxa with stridulatory patch on mesal surface .... *Sedomaya* Kimsey and Wasbauer

CHECKLIST OF  
THE BRACHYCISTIDINAE

**Genus *Acanthetropis* Wasbauer**

Figs 2, 14, 28, 31, 32

*Acanthetropis* Wasbauer 1958:139. Type species:  
*Acanthetropis lamellatus* Wasbauer 1958:140.  
Original designation. Distribution: USA:  
South Dakota, south to Baja California Sur,  
west to California.

Species List

*aequalis* (Fox) 1899:284. (*Brachycistis*). Holotype  
male; Nevada (ANSP).\*

*lamellatus* Wasbauer 1958:140. (*Acanthetropis*).  
Holotype male; Mexico: Baja California, La  
Paz (CAS).\*

*noctivaga* (Bradley) 1917:272. (*Brachycistis*). Ho-  
lotype male; USA: Nevada, Las Vegas (CU).\*

*normalis* (Malloch) 1917:8. (*Brachycistis*). Holo-  
type male; USA: South Dakota, Cedar Pass  
(NMNH).\*

**Genus *Brachycistellus* Baker**

Figs 3, 15, 33

*Brachycistellus* Baker 1909:177. Type species:  
*Brachycistellus figitiformis* Baker 1909:177.  
Original designation. Distribution: USA:  
southern California.

Species List

*figitiformis* (Baker) 1909:178. (*Brachycistis*). Holo-  
type male; USA: California, Claremont  
(NMNH).\*

**Genus *Brachycistina* Malloch**

Figs 5, 16, 34, 35

*Brachycistina* Malloch 1926:25. Type species  
*Brachycistis acuta* Malloch 1926:25. Described  
as a subgenus of *Brachycistis* Fox. Elevated  
by Wasbauer (1966). Distribution: USA: Ar-  
izona.

Species List

*acuta* Malloch 1926:25. (*Brachycistina*). Holotype  
male; USA: Arizona, Arlington (NMNH).\*

**Genus *Brachycistis* Fox**

Figs 4, 17, 27, 36, 37

*Brachycistis* Fox 1893:7. Type species: *Brachycistis*  
*petiolatus* Fox 1893:8. Original designation.  
Distribution: southwestern North America  
(USA, northwestern Mexico).

*Brachycistus* (!) Cockerell and Casad. 1894:295.

*Glyptomeopa* Ashmead 1898:251. Type species:  
*Glyptometopa americana* Ashmead 1898:251.  
Monobasic. Synonymized by Wasbauer 1968.

*Glyptometopa* (!) Fox 1899:289.

*Brachycystis* (!) Viereck 1906:289.

*Bruesiella* Mann 1914:182. Type species: *Brue-*  
*siella formicaria* Mann 1914:182. Original de-  
signation. Synonymized by Kimsey 2006.

*Eurycros* Mickel & Krombein 1942:666. Type  
species: *Eurycros furtivus* Mickel & Krombein  
1942:667. Orig. designation. Synonymized by  
Krombein 1967.

*Aulacros* Mickel & Krombein 1942:664. Type  
species: *Aulacros latior* Mickel & Krombein  
1942:665. Original designation. Synonymized  
by Kimsey 2006.

## Species List

- agama* (Dalla Torre) 1897:7. (*Mutilla*). Replacement name for *atrata* (Blake) 1879. Nec *Mutilla atratus* Linnaeus 1767:966.
- atrata* (Blake) 1879:253. (*Agama*). Holotype male; USA: Nevada (ANSP). Synonymized by Wasbauer 1966.
- contiguus* Fox 1899:282. (*Brachycistis*). Syntype males; USA: Nevada (ANSP). Synonymized by Wasbauer 1966.
- nigritus* Fox 1899:282. (*Brachycistis*). Syntype males; USA: Nevada, Washington (ANSP). Synonymized by Wasbauer 1966.
- nudus* Fox 1899:281. (*Brachycistis*). Holotype male; USA: California (ANSP). Synonymized by Wasbauer 1966.
- francisca* (Mickel & Krombein) 1942:656. (*Glyptometopa*). Holotype female; USA: California, San Francisco (CAS). Synonymized by Wasbauer 1968.
- alcanor* (Blake) 1879:264. (*Agama*). Holotype male; USA: Arizona (ANSP).\*
- tysias* Cameron 1900:396. Holotype male; Mexico: northern Sonora (BMNH).\* **New synonymy.**
- dubitatus* Cameron 1900:397. (*Brachycistis*). Holotype male; Mexico: northern Sonora (BMNH).\* **New synonymy.**
- sciron* Cameron 1900:400. (*Brachycistis*). Holotype male; Mexico: northern Sonora (BMNH).\* **New synonymy.**
- cremastogaster* Melander 1903:329. (*Brachycistis*). Holotype male; Texas (Repository unknown). Synonymized by Wasbauer 1966.
- ampla* (Blake) 1879:252. (*Agama*). Holotype male; USA: Colorado (ANSP).
- americana* (Ashmead) 1898:251. (*Glyptometopa*). Holotype female; USA: California, Alameda Co. (NMNH).
- arenivaga* Bradley 1917:269. (*Brachycistis*). Holotype male; USA: California, Imperial Co. (CU).\*
- eripis* Bradley 1917:266. (*Brachycistis*). Holotype male; USA: California, Imperial Co., Calexico (CU). Synonymized by Wasbauer 1966.\*
- carinata* Fox 1899:283. (*Brachycistis*). Holotype male; USA: California (ANSP).
- convergens* (Mickel & Krombein) 1942:657. (*Glyptometopa*). Holotype female; USA: California, Santa Monica (NMNH).
- convexa* Wasbauer 1966:51. (*Brachycistis*). Holotype male; USA: California, Imperial Co. (MCZ).
- cruenta* Wasbauer 1966:53. (*Brachycistis*). Holotype male; USA: Texas, Nueces Co., Corpus Christi (CAS).\*
- curvata* Malloch 1926:16. (*Brachycistis*). Holotype male; USA: Arizona (NMNH).\*
- davidi* Wasbauer 1966:56. (*Brachycistis*). Holotype male; USA: Texas, Jeff Davis Co. (CAS).
- elegantula* Cockerell & Casad 1894:295. (*Brachycistis*). Holotype male; USA: New Mexico, Dona Ana Co., Las Cruces (NMNH).\*
- exornatus* Cameron 1900:402. (*Brachycistis*). Holotype male; Mexico: northern Sonora (BMNH, type lost?).
- formicaria* (Mann) 1914:182. (*Bruesiella*). Holotype female; Mexico: Hidalgo (MCZ).
- furtivus* (Mickel & Krombein) 1942:667. (*Eurycros*). Holotype female; USA: Arizona, Tucson (UMSP).
- glabrella* Cresson 1865b:441. (*Brachycistis*). Holotype male; USA: New Mexico, Sandoval Co. (ANSP).\*
- dentata* Bradley 1917:263. (*Brachycistis*). Holotype male; USA: New Mexico, Jemez Spr. (CU). Synonymized by Wasbauer 1966.
- micrommata* Bradley 1917:265. (*Brachycistis*). Holotype male; USA: California, Alameda Co. (CU). Synonymized by Wasbauer 1966.
- utahensis* Malloch 1926:17. (*Brachycistis*). Holotype male; USA: Utah (NMNH). Synonymized by Wasbauer 1966.
- dakotensis* Malloch 1926:20. (*Brachycistis*). Holotype male; USA: North Dakota, Edgemont (NMNH). Synonymized by Wasbauer 1966.
- melanocephala* Malloch 1926:19. (*Brachycistis*). Holotype male; USA: Utah, Uinta National Forest (NMNH). Synonymized by Wasbauer 1966.
- idiotes* Cockerell 1895a:63. (*Brachycistis*). Holotype male; USA: New Mexico (Repository unknown).
- imitans* Malloch 1926:23. (*Brachycistis*). Holotype male; USA: California, Los Angeles Co. (NMNH).\*
- inaequalis* Fox 1899:282. (*Brachycistis*). Lectotype male (design by Krombein 1954); USA: California, Los Angeles Co. (NMNH).\*
- nevadensis* Fox 1899:283. (*Brachycistis*). Holotype male; USA: Nevada (ANSP). Synonymized by Wasbauer 1966.\*
- nocticola* Bradley 1917:289. (*Brachycistis*). *Lapsus calumni*: name used in error in Explanation of Figures, no holotype indicated or

- description given, as discussed by Krombein 1954. Synonymized by Wasbauer 1966.
- indiscreta* Fox 1899:284. (*Brachycistis*). Holotype male; USA: Arizona, Cochise Co., Wilcox (NMNH).\*
- stictinota* Viereck 1906:190. (*Brachycistis*). Holotype male; USA: Kansas: Clark Co. (SMEK). Synonymized by Wasbauer 1966.\*
- junceae* Wasbauer 1966:35. (*Brachycistis*). Holotype male; USA: California, San Bernardino (CAS).
- lacustris* Malloch 1926:24. (*Brachycistis*). Holotype male; USA: Nevada, Pyramid Lk. (NMNH).\*
- hurdi* Wasbauer 1966:39. (*Brachycistis*). Holotype male; USA: California, Riverside Co. (CAS). Described as a subspecies of *lacustris* Malloch. **New synonymy.**
- latior* (Mickel & Krombein) 1942:665. (*Aulacros*). Holotype female; USA: California, Palm Springs (CAS).
- linsleyi* Wasbauer 1966:21. (*Brachycistis*). Holotype male; Arizona: Globe (CAS).\*
- longula* Wasbauer 1966:39. (*Brachycistis*). Holotype male; USA: California, Riverside Co. (CAS).
- nitida* (Cresson) 1875:710. (*Agama*). Holotype male; Colorado (ANSP).
- lepidus* (Blake) 1886:269. (*Photopsis*). Holotype male; Colorado (ANSP). Synonymized by Wasbauer 1966.\*
- nitida* (Blake) 1886:267. (*Photopsis*). Holotype male; Colorado (ANSP). Synonymized by Wasbauer 1966.\*
- sobrina* (Blake) 1886:268. (*Photopsis*). Holotype male; Colorado (ANSP). Synonymized by Wasbauer 1966.
- petiolata* Fox 1893:8. (*Brachycistis*). Holotype male; Mexico: Baja California, Calmalli Mines (CAS).\*
- gaudii* Cockerell 1901:340. (*Brachycistis*). Lectotype male (designated herein); USA: California, San Diego Co., La Jolla (NMNH). Synonymized by Wasbauer 1966.
- parva* Malloch 1926:14. (*Brachycistis*). Holotype male; USA: California (NMNH). Synonymized by Wasbauer 1966.
- protracta* Bradley 1917:270. (*Brachycistis*). Holotype male; USA: Arizona, Phoenix (ANSP).
- semiatra* Malloch 1926:24. (*Brachycistis*). Holotype male; USA: Washington, Adams Co., (NMNH)
- subquadrata* Fox 1899:282. (*Brachycistis*). Holotype male; USA: California, San Diego Co., San Diego (ANSP).
- intermedia* Malloch 1926:18. (*Brachycistis*). Holotype male; USA: California, San Diego Co., San Diego (NMNH). Synonymized by Wasbauer 1966.
- texana* Malloch 1926:12. (*Brachycistis*). Holotype male; USA: Texas, Cotulla (NMNH).\*
- timberlakei* Wasbauer 1966:70. (*Brachycistis*). Holotype male; USA: California, San Diego Co. (CAS).
- triangularis* Fox 1899:284. (*Brachycistis*). Holotype male; USA: Arizona (ANSP).\*
- verticalis* Malloch 1926:19. (*Brachycistis*). Holotype male; USA: Arizona, Fort Grant (NMNH).\*
- vigilax* Cameron 1900:397. (*Brachycistis*). Holotype male; Mexico: northern Sonora (BMNH).
- fulvilabris* Cameron 1900:399. (*Brachycistis*). Holotype male; Mexico: northern Sonora (BMNH).\* **New synonymy.**
- arines* Cameron 1900:401. (*Brachycistis*). Holotype male; Mexico: northern Sonora (BMNH).\* **New synonymy.**
- ioachinensis* Bradley 1917:267. (*Brachycistis*). Holotype male; USA: California, Fresno Co., Coalinga (CU).\* **New synonymy.**
- washingtona* Malloch 1926:21. (*Brachycistis*). Holotype male; USA: Washington, Ritzville (NMNH). Synonymized by Wasbauer 1966.\*
- subcarinata* Malloch 1926:11. (*Brachycistis*). Holotype male; USA: Arizona, Higley (NMNH). Synonymized by Wasbauer 1966.\*
- rugosa* Malloch 1926:11. (*Brachycistis*). Holotype male; USA: Nevada, Golconda (NMNH). Synonymized by Wasbauer 1966.\*
- nigrifrons* Malloch 1926:16. (*Brachycistis*). Holotype male; USA: Arizona: Graham Mount., Ash Crk. (NMNH). Synonymized by Wasbauer 1966.\*

## Genus *Brachymaya* Kimsey & Wasbauer

Figs 6, 18, 38

*Brachymaya* Kimsey & Wasbauer 1998b:66. Type species: *Brachymaya mexicana* Kimsey & Wasbauer 1998:67. Original designation. Distribution. USA: Baja California.



## Species List

*mexicana* Kimsey & Wasbauer 1998b:67. (*Brachymaya*). Holotype male; Mexico: Baja California, San Augustine (LACM).

Genus *Colocistis* Krombein

Figs 7, 19, 30, 39, 40

*Colocistis* Krombein 1942:65. Type species: *Colocistis pilosa* Krombein 1942:66. Original designation. Distribution: USA: California, Arizona.

*Aglyptacros* Mickel & Krombein 1942:669. Type species: *Aglyptacros paxillatus* (Mickel & Krombein) 1942:673. Original designation. Synonymized by Kimsey 2006

## Species List

*brevis* (Fox) 1899:285. (*Brachycistis*). Holotype male; USA: California (NMNH, lost?)\*

*castanea* (Cresson) 1865a:388. (*Brachycistis*). Holotype male; USA: California (ANSP)\*

*crassa* (Bradley) 1917:277. (*Brachycistis*). Holotype male; USA: California, Fresno Co., Coalinga (CU)\*

*eremi* (Bradley) 1917:279. (*Brachycistis*). Holotype male; USA: California, Imperial Co., Calexico (CU).

*paxillatus* (Mickel & Krombein) 1942:673. (*Aglyptacros*). Holotype female; USA: Colorado, La Junta (NMNH).

*pilosa* Krombein 1942:66. (*Colocistis*). Holotype male; USA: California, San Diego Co., San Diego (NMNH)\*

*segredentatus* (Mickel & Krombein) 1942:671. (*Aglyptacros*). Holotype female; USA: Arizona, Benson (MCZ).

*sulcatus* (Mickel & Krombein) 1942:674. (*Aglyptacros*). Holotype female; USA: Texas, Valentine (SMEK).

*stygia* (Bradley) 1917:276. (*Brachycistis*). Holotype male; USA: Arizona, Nogales (CU)\*

*thermarum* (Bradley) 1917:274. (*Brachycistis*). Holotype male; USA: Arizona, Hot Springs (CU).

Genus *Dolichetropis* Wasbauer

Figs 8, 20, 29, 41

*Dolichetropis* Wasbauer 1968a:191. Type species:

*Dolichetropis flavida* Wasbauer 1968a:192.

Original designation. Distribution: Mexico: Baja California Sur.

## Species List

*flavida* Wasbauer 1968a:192. (*Dolichetropis*). Holotype male; Mexico: Baja California Sur, San Ignacio (CAS)\*

Genus *Glyptacros* Mickel & Krombein

*Glyptacros* Mickel & Krombein 1942:660. Type species: *Glyptacros angustior* Mickel & Krombein 1942:660. Original designation. Distribution. Southwestern USA: California, Arizona, Utah, Wyoming, New Mexico, Texas; Mexico: Baja California Sur, Chihuahua, Hidalgo, Sonora.

*Xeroglypta* Mickel & Krombein 1942:663. Type species: *Xeroglypta egregia* Mickel & Krombein 1942:663. Original designation. Synonymized by Kimsey 2006.

*Astigmometopa* Mickel & Krombein 1942:668. Type species: *Astigmometopa emarginata* Mickel & Krombein 1942:668. Original designation. Synonymized under *Brachycistis* by Wasbauer 1971. Removed from synonymy under *Brachycistis* and synonymized under *Glyptacros* by Kimsey 2006.

## Species List

*angustior* Mickel & Krombein 1942:660. (*Glyptacros*). Holotype female; USA: Arizona (ANSP).

*ashmeadi* Mickel & Krombein 1942:661. (*Glyptacros*). Holotype female; no locality given (NMNH).

*egregia* (Mickel & Krombein) 1942:663. (*Xeroglypta*). Holotype female; USA: California, Palm Springs (UMSP).

*emarginata* (Mickel & Krombein) 1942:668. (*Astigmometopa*). Holotype female; USA: Texas, Valentine (SMEK).

*eureka* (Banks) 1912:202. (*Glyptometopa*). Holotype female; USA: Arizona, Palmerlee (MCZ).

Genus *Hadrocistis* Wasbauer

Figs 9, 13, 21, 42

*Hadrocistis* Wasbauer 1968a:185. Type species: *Hadrocistis bicolor* Wasbauer 1968a:187. Original designation. Distribution: USA: California, Imperial Co.; Mexico: Baja California, Sinaloa.

## Species List

- bicolor* Wasbauer 1968a:187. (*Hadrocistis*). Holotype male; USA: California, Imperial Co., 6 mi w Glamis (CAS).\*
- slanskyae* Wasbauer 1968a:188. (*Hadrocistis*). Holotype male; USA: California, Imperial Co., 6 mi w Glamis (CAS).\*

Genus *Paraquemaya* Kimsey & Wasbauer

Figs 10, 22, 25, 43, 44

- Paraquemaya* Kimsey and Wasbauer 1998b:67. Type species: *Paraquemaya pallida* Kimsey & Wasbauer 1998:71. Distribution. USA: Arizona; Mexico: Baja California Sur, Sonora.

## Species List

- bajaensis* Kimsey and Wasbauer 1998b:69. (*Paraquemaya*). Holotype male; Mexico: Baja California Sur, 14 mi s El Arco (UCRC).\*
- bitincta* Kimsey and Wasbauer 1998b:70. (*Paraquemaya*). Holotype male; USA: Arizona, Pima Co., Organ Pipe (UCRC).\*
- maxima* Kimsey and Wasbauer 1998b:71. (*Paraquemaya*). Holotype male; Mexico: Sonora, 22 km se Quitovac (UCRC).\*
- pallida* Kimsey and Wasbauer 1998b:71. (*Paraquemaya*). Holotype male; Mexico: Baja California Sur, 4 mi wsw Miraflores (UCDC).\*

Genus *Sedomaya* Kimsey & Wasbauer

Figs 12, 24, 26, 47

- Sedomaya* Kimsey & Wasbauer 1998b:72. Type species: *Sedomaya glamisensis* Kimsey & Wasbauer. Original designation. Distribution. USA: California, Imperial Co.

## Species List

- glamisensis* Kimsey & Wasbauer 1998b:72. (*Sedomaya*). Holotype male; USA: California, Imperial Co., Glamis (UCDC).

Genus *Stilbopogon* Mickel & Krombein

Figs 11, 23, 45, 46

- Stilbopogon* Mickel & Krombein 1942:658. Type species: *Stilbopogon alutacea* Mickel & Krombein 1942:659. Original designation. Synonymized by Wasbauer 1971 under *Brachycistis* Fox. Distribution. USA: California, Nevada,

Arizona, New Mexico, Texas; Mexico: Baja California, Sonora; Costa Rica: Guanacaste; Colombia: Magdalena.

- Quemaya* Pate 1947:139. Type species: *Brachycistis paupercula* Bradley 1917:282. Original designation. Synonymized by Kimsey 2006.

## Species List

- alutacea* Mickel & Krombein 1942:659. (*Stilbopogon*). Holotype female; USA: New Mexico, Deming (NEW YORK).
- arenicola* (Wasbauer) 1967:169. (*Quemaya*). Holotype male; USA: California, Imperial Co., 6 mi nw Glamis (CAS).\*
- confusa* (Kimsey & Wasbauer) 1998b:42. (*Quemaya*). Holotype male; Mexico: Sonora, 6 km nnw San Carlos (UCDC).\*
- costaricana* (Kimsey & Wasbauer) 1998b:43. (*Quemaya*). Holotype male; Costa Rica: Guanacaste Prov., 14 km s Cañas (EMUS).\*
- eurekaensis* (Kimsey & Wasbauer) 1998b:43. (*Quemaya*). Holotype male; USA: California, Inyo Co., Eureka Valley, dunes (UCDC).\*
- inermis* (Malloch) 1924:23. (*Brachycistis*). Holotype male; USA: Arizona: Higley (NMNH).\*
- marcida* (Bradley) 1917:283 (*Brachycistis*). Holotype male; USA: California, Imperial Co. (CU).\*
- megalops* (Kimsey & Wasbauer) 1998b:44. (*Quemaya*). Holotype male; USA: California, Riverside Co., 5 mi nw Desert Center (UCDC).\*
- mexicana* (Kimsey & Wasbauer) 1998b:43. (*Quemaya*). Holotype male; Mexico: Baja California, 1 km s El Rosario (UCDC).\*
- paupercula* (Bradley) 1917:282. (*Brachycistis*). Holotype male; USA: California, Imperial Co. (CU).\*
- perpunctata* (Cockerell) 1895b:291. (*Brachycistis*). Holotype male; USA: New Mexico, Dona Ana Co., Las Cruces (Repository unknown).
- sonorensis* (Kimsey & Wasbauer) 1998b:46. (*Quemaya*). Holotype male; Mexico: Sonora, 6 km nnw San Carlos (UCDC).\*

## ACKNOWLEDGMENTS

Our thanks go to the collections and collection managers who made this study possible, and to Maria Garcia who rendered many of the ink drawings.

## LITERATURE CITED

- Ashmead, W. H. 1898. Thynnidae in the United States. *Psyche* 8: 251.

- Baker, C. F. 1907. A new mutillid near *Brachycistis* from California. *Invertebrata Pacifica* 1: 177–178.
- Banks, N. 1912. New Scoliidae. *Canadian Entomologist* 45: 197–203.
- Blake, C. A. 1879. Catalog of the Mutillidae of North America with descriptions of new species. *Transactions of the American Entomological Society* 7: 243–254.
- Blake, C. A. 1886. Monograph of the Mutillidae of North America. *Transactions of the American Entomological Society* 13: 179–280.
- Bradley, J. C. 1917. Contributions toward a monograph of the Mutillidae and their allies of America north of Mexico. IV. A review of the Myrmosidae. *Transactions of the American Entomological Society* 43: 247–290.
- Brothers, D. J. 1975. Phylogeny and classification of the aculeate Hymenoptera, with special reference to Mutillidae. *University of Kansas Science Bulletin* 50: 483–648.
- Brothers, D. J. and J. M. Carpenter. 1993. Phylogeny of Aculeata: Chrysidoidea and Vespoidea. *Journal of Hymenoptera Research* 2: 227–301.
- Cameron, P. 1900. Fossores. *Biologia Centrali-Americana* 2: 397–402.
- Cockerell, T. D. A. 1895a. Descriptions of new Hymenoptera. *Entomological News* 6: 60–64.
- Cockerell, T. D. A. 1895b. Descriptions of new Hymenoptera. *Transactions of the American Entomological Society* 22: 289–297.
- Cockerell, T. D. A. 1901. Species of *Brachycistis* from southern California. *Canadian Entomologist* 45: 340–341.
- Cockerell, T. D. A. and J. E. Casad. 1894. New species of Mutillidae. *Entomological News*, Philadelphia 5: 293–296.
- Cresson, E. T. 1865a. Descriptions of some new species of Mutilla from California. *Proceedings of the Entomological Society of Philadelphia* 4: 385–390.
- Cresson, E. T. 1865b. Catalog of Hymenoptera in the collection of the Entomological Society of Philadelphia, from Colorado Territory. *Proceedings of the Entomological Society of Philadelphia* 4: 426–488.
- Cresson, E. T. 1875. Report upon the collections of Hymenoptera. Chapter VII in: Wheeler, W. M. ed. *U.S. Geographic surveys west of the 100<sup>th</sup> meridian. V. Zoology*.
- Dalla Torre, C. G. 1897. *Catalogus Hymenopterorum*. 1. Family Mutillidae 8: 1–99.
- Farris, J. S. 1988. *Hennig86*, version 1.5 manual/software and MSDOS program. Distributed by the author. Port Jefferson Station, New York.
- Fox, W. J. 1893. Report on some Mexican Hymenoptera, principally from Lower California. *Proceedings of the California Academy of Sciences* (2)4: 1–25.
- Fox, W. J. 1899. The North American Mutillidae. *Transactions of the American Entomological Society* 25: 219–300.
- Kimsey, L. S. 1991. Relationships among the tephritid wasp subfamilies. *Systematic Entomology* 16: 427–438.
- Kimsey, L. S. 2006. Competing taxonomies: reexamination of the female-based genera of Brachycistidae. *Zootaxa*. In press.
- Kimsey, L. S. and M. S. Wasbauer. 1998a. Revision of the American tephritid genus *Quemaya* Pate. *Journal of Hymenoptera Research* 71: 38–47.
- Kimsey, L. S. and M. S. Wasbauer. 1998b. New Genera and Species of Brachycistidine Wasps from Southwestern North America. *Journal of Hymenoptera Research* 8: 65–73.
- Krombein, K. V. 1942. A new genus and species of Brachycistidae. *Proceedings of the Entomological Society of Washington* 44: 67–68.
- Krombein, K. V. 1954. The identity of *Brachycistis nocticola* Bradley. *Proceedings of the Entomological Society of Washington* 56: 85–86.
- Krombein, K. V. 1967. Family Tephritidae, p. 325 in: Krombein, K. V. and B. D. Burks eds. *Hymenoptera of America north of Mexico*. Synoptic Catalog. Second Supplement. U.S. Government Printing Office, Washington, D.C.
- Linnaeus, C. 1767. *Systema Naturae*. 12<sup>th</sup> edition, 1. Holmiae.
- Malloch, J. R. 1924. A new species of the genus *Brachycistis*. *Bulletin of the Brooklyn Entomological Society* 19: 23.
- Malloch, J. R. 1926. Systematic notes on and descriptions of North American wasps of the subfamily Brachycistidae. *Proceedings of the US National Museum* 68: 1–28.
- Mann, W. M. 1914. Some myrmecophilous insects from Mexico. *Psyche* 21: 182.
- Melander, A. L. 1903. Notes on the North American Mutillidae, with description of new species. *Transactions of the American Entomological Society* 29: 291–330.
- Mickel, C. E. and K. V. Krombein. 1942. *Glyptometopa* Ashmead and related genera in the Brachycistidae with descriptions of new genera and species. *American Midland Naturalist* 28: 648–679.
- Nixon, K. C. 2002. *WinClada* ver. 1.00.08. Published by the author, Ithaca, NY.
- Goloboff, P. 1999. About NONA. [http://www.cladistics.com/about\\_nona.htm](http://www.cladistics.com/about_nona.htm).
- Pate, V. S. L. 1947. A conspectus of the Tephritidae, with particular reference to the Nearctic forms. *Journal of the New York Entomological Society* 55: 115–145.
- Viereck, H. L. 1906. Notes and descriptions of Hymenoptera from the Western United States. *Transactions of the American Entomological Society* 32: 173–247.
- Wasbauer, M. S. 1958. A new genus of brachycistidine wasps. *Pan-Pacific Entomologist* 34: 139–142.
- Wasbauer, M. S. 1966. Revision of the male wasps of the genus *Brachycistis* in America north of Mexico.



- University of California Publications in Entomology* 43: 1-96.
- Wasbauer, M. S. 1967. A new species of *Quemaya* from the Colorado Desert of California. *Proceedings of the Biological Society of Washington* 80: 169-172.
- Wasbauer, M. S. 1968a. New genera of male Brachycistidinae with a redescription of *Brachycistellus* Baker and a key to North American genera. *Pan-Pacific Entomologist* 44: 184-197.
- Wasbauer, M. S. 1968b. Some sex associations in the Brachycistidinae. *Pan-Pacific Entomologist* 44: 297-299.
- Wasbauer, M. S. 1971. A sex association in the genus *Brachycistis*. *Pan-Pacific Entomologist* 47: 211-214.

## Fauna and Biogeography of the Bees and Wasps of the Cook Islands (Hymenoptera Aculeata)

MICHAEL KUHLMANN

Institute of Landscape Ecology, University of Münster, Robert-Koch-Str. 26, D-48149 Münster,  
Germany; email: kuhlmmi@uni-muenster.de

---

*Abstract.*—A total of 19 species of bees and aculeate wasps is currently known from the Cook Islands with six of them recorded for the first time: *Pison* spec. 2, *Sceliphron lactum* (F. Smith, 1856), *Ceratina* (*Neoceratina*) *dentipes* Friese, 1914, *Megachile* (*Eutricharaea*) spec. 1, *M.* (*E.*) spec. 2. The following three species are presumably indigenous: *Anterhynchium* (*Epidynerus*) *rufipes* (Fabricius, 1775), *Parodynerus bicinctus* (Fabricius, 1781), *Tachysphex* f. *fauiensis* Cheesman, 1928. Three more species are possibly indigenous but their status remains uncertain due to taxonomic problems: *Pison* spec. 1, *Pison* spec. 2, *Megachile* (*Eutricharaea*) spec. 1. A comparative analysis of faunistic data from other Pacific islands showed that the indigenous aculeate fauna of the Cook Islands is extremely depauperate. In general the number of species, especially parasitic taxa, and endemics decline from west to east with the remote archipelagos of Polynesia possessing the most depauperate aculeate faunas consisting only of widespread species.

---

Traditionally the oceanic Pacific islands are divided into Micronesia, Melanesia and Polynesia, originally on the basis of their indigenous aboriginal peoples, with the Cook Islands as a part of the latter (Crocombe 2001). Polynesia is a vast triangular area with the edges formed by Hawaii in the north, Easter Island (Rapa-nui) in the southeast and New Zealand in the southwest, including the territories of Hawaii, Kiribati (part), Tuvalu, Tokelau, Wallis & Futuna, Samoa, American Samoa, Tonga, Niue, Cook Islands, French Polynesia, Pitcairn, Easter Island and New Zealand (Crocombe 2001). Other than New Zealand, that has a continental origin, the islands of Polynesia are of volcanic origin. To colonize these isolated islands the terrestrial fauna and flora had to cross large areas of open ocean. Because only a small fraction of the bee and wasp species is capable of long distance dispersal (Michener 1979, 2000) the fauna derived from relatively few immigrants. As a result oceanic island faunas are usually depau-

perate. However, isolation and a highly diverse environment can lead to remarkable radiations, such as the 60 species of *Hylaeus* (*Nesoprosopis*) (Colletidae) and 99 *Odynerus* species (Vespididae) in the Hawaiian Islands (Nishida 1994, Daly and Magnacca 2003) and the endemic genus *Echthralictus* in Samoa (Michener 2000). Interestingly, endemic forms among the bees and wasps seem to have developed only on the high islands. The low coral atolls have only a sparse, introduced fauna derived mainly from the Oriental region (Krombein 1949b, 1950). Except for Hawaii (Nishida 1994, Daly & Magnacca 2003, Snelling 2003) and Samoa (Perkins and Cheesman 1928, Williams 1928) the bees and aculeate wasps of Polynesia are poorly studied (compilation in Williams 1947). It is the intention of his study to present the results of an investigation of the bees and aculeate wasps of the islands of Rarotonga and Mangaia made in 2004, including other available data about the Cook Islands. The biogeographic situation is discussed in

a Polynesian and Pacific context including a summary of data available for Pacific Islands.

## MATERIALS AND METHODS

The Cook Islands consist of 15 islands located in the central South Pacific between the Society Islands to the east and Tonga and Samoa to the west. During a stay on the Cook Islands from 13<sup>th</sup> September to 7<sup>th</sup> October 2004 I collected on the two largest and most southerly of its 15 islands: Rarotonga with the capital Avarua (67 km<sup>2</sup>) and Mangaia (51 km<sup>2</sup>). Both have a tropical climate with Rarotonga being a geologically young (about 2 million years) high volcanic island (maximum elevation 653 m). The geologically old (about 18 million years) Mangaia is classified as a makatea island consisting of an uplifted karstified limestone rim encircling a central volcanic core (maximum elevation 169 m) (Hein et al. 1997). The specimens collected there are deposited in my collection. Reference material is located in the collections of various specialists (see acknowledgements). Additional records were taken from the Cook Islands Biodiversity Database (McCormack 2004). In the faunistic part families are in systematic, species in alphabetical order.

## LIST OF WASPS AND BEES OF THE COOK ISLANDS

### Chrysididae

#### *Chrysis* sp.

*Distribution*.—This unidentified species is known from Rarotonga (Totokoitu Research Station) and Atiu (McCormack 2004). Probably introduced.

*Biology*.—Cuckoo wasps of the genus *Chrysis* are known as parasites of a broad spectrum of aculeate wasps and bees (Kimsey 1990). The host of this species is unknown.

*Specimens examined*.—

### Vespidae

#### *Anterhynchium* (*Epidynerus*) *rufipes* (Fabricius, 1775)

*Distribution*.—Widespread in the Pacific region: Australia, New Guinea, Fiji, Tonga, Samoa, Tuvalu, Tokelau, Niue, Society Islands, Marquesas (Giordani Soika 1957, Carpenter, pers. comm.). Probably indigenous to the Cook Islands.

Previous records are from Rarotonga (1925, leg. G. Wilder; 1977, leg. Kraus, 1999), Atiu (1925, leg. G. Wilder; 1976, leg. Krauss) and Aitutaki (1960, 1976, leg. Krauss; Krauss 1961) but missing on Pukapuka (McCormack 2004). Probably present on most islands of the archipelago.

*Biology*.—The species can be regularly observed hunting or visiting flowers in gardens, along road sides and on fallow land. Two males from Mangaia carry some phoretic mites.

*Specimens examined*.—Rarotonga: Arorangi, fallow land, 10 m (21°12'54"S 159°49'42"W), 2 ♀, 19.ix.2004; Arorangi, upper beach, 5 m (21°12'45"S 159°49'39"W), 1 ♂, 21.ix.2004; 1 ♀, 4.x.2004; Mangaia: Ivirua, on Makatea, 30 m (21°55'15"S 157°53'21"W), 1 ♀, 1 ♂, 22.ix.2004; 3 ♀, 3 ♂, 27.ix.2004.

#### *Delta esuriens okinawae* Giordani Soika, 1986

*Distribution*.—The specimens correspond best to this subspecies that is known from China and Taiwan. It differs very little from typical *D. esuriens* from India and might be conspecific (Carpenter, pers. comm.). Introduced to the Cook Islands.

Previously known only from Rarotonga (Tupapa, xii.2002, leg. G. McCormack) (McCormack 2004).

*Biology*.—Species of *Delta* construct free clay nests on rocks, houses or wood and provision the cells with paralyzed caterpillars (Mader 2000).

*Specimens examined*.—Rarotonga: Arorangi, upper beach, 5 m (21°14'20"S 159°49'40"W), 1 ♂, 18.ix.2004; Mangaia: S Ivirua, on Makatea, 30 m (21°55'52"S 157°52'42"W), 1 ♀, 26.ix.2004.



*Pachodynerus nasidens* (Latreille, 1817)

**Distribution.**—This species originated from the Neotropics and is now widespread throughout the Pacific region (Carpenter, pers. comm.). Introduced to the Cook Islands.

In the Cook Islands this species is very common and known from Rarotonga, Atiu, Aitutaki and Pukapuka (Krauss 1961, McCormack 2004). *P. nasidens* is probably present on most islands of the archipelago.

**Biology.**—The species can be regularly observed hunting or visiting flowers in gardens, along road sides and on fallow land, with a preference for the introduced Mexican Fire-plant (*Euphorbia cyathophora* J.A. Murray) (Euphorbiaceae).

**Specimens examined.**—Rarotonga: Arorangi, upper beach, 5 m (21 14'20"S 159 49'40"W), 1 ♀, 5 ♂, 15.ix.2004; 2 ♂, 18.ix.2004; Arorangi, fallow land, 10 m (21 12'54"S 159 49'42"W), 2 ♀, 5 ♂, 19.ix.2004; Arorangi, upper beach, 5 m (21 12'45"S 159 49'39"W), 1 ♀, 7 ♂, 20.ix.2004; 2 ♂, 21.ix.2004; 1 ♂, 4.x.2004; Mangaia: Ivirua, on Makatea, 30 m (21 55'15"S 157 53'21"W), 2 ♂, 22.ix.2004; Ivirua, Taro gardens, 30 m (21 55'20"S 157 53'53"W), 1 ♀, 1 ♂, 23.ix.2004; S Ivirua, on Makatea, 30 m (21 55'52"S 157 52'42"W), 1 ♂, 26.ix.2004.

*Parodynerus bicinctus* (Fabricius, 1781)

**Distribution.**—Widespread in the Pacific region: New Guinea, Philippines, Fiji, Tonga, Tuvalu, Samoa, Cook Islands, Society Islands, Gambier Islands, Marquesas, Tuamotu Archipelago (Giordani Soika 1957, Carpenter, pers. comm.). Probably indigenous to the Cook Islands.

In the Cook Islands this species is very common and known from Rarotonga (1979, leg. Krauss), Atiu (1976, leg. Krauss), Mitiaro (1979, leg. ?Krauss) and Aitutaki (1977, leg. Krauss; Krauss 1961) but missing on Pukapuka (McCormack 2004). Probably present on most islands of the archipelago.

**Biology.**—This very common species can be regularly observed hunting or visiting

flowers in gardens, along road sides and on fallow land, with preference for the introduced Mexican Fire-plant (*Euphorbia cyathophora* J.A. Murray) (Euphorbiaceae).

**Specimens examined.**—Rarotonga: Arorangi, upper beach, 5 m (21 14'20"S 159 49'40"W), 1 ♀, 15.ix.2004; 1 ♂, 18.ix.2004; Arorangi, fallow land, 10 m (21 12'54"S 159 49'42"W), 1 ♀, 19.ix.2004; Arorangi, upper beach, 5 m (21 12'45"S 159 49'39"W), 1 ♀, 7 ♂, 20.ix.2004; 1 ♀, 6 ♂, 21.ix.2004; 1 ♀, 2 ♂, 4.x.2004; Mangaia: Ivirua, Taro gardens, 30 m (21 55'20"S 157 53'53"W), 1 ♀, 1 ♂, 23.ix.2004; S Ivirua, on Makatea, 30 m (21 55'52"S 157 52'42"W), 1 ♀, 26.ix.2004; Ivirua, on Makatea, 30 m (21 55'15"S 157 53'21"W), 2 ♀, 5 ♂, 22.ix.2004; 2 ♀, 1 ♂, 27.ix.2004.

*Polistes jokahamae* Radoszkowski, 1887

**Distribution.**—India, China, Mongolia, Korea, Japan, Taiwan, Society Islands, Tuamotu Archipelago; introduced to Hawaii (Carpenter 1996, as *P. jadvigae*). Probably introduced to the Cook Islands.

Previous records are from Rarotonga (iv.1925, leg. G. Wilder; xii.1977, Titikaveka, lowlands, leg. N.L.H. Krauss; xii.1977, Avarua lowlands, leg. N.L.H. Krauss, v.2002, Avana valley, leg. G. McCormack), Atiu (xi.1977, central plateau, leg. N.L.H. Krauss) and Aitutaki (ii.1960, leg. N.L.H. Krauss; xi.1977, Tautu, leg. N.L.H. Krauss; Krauss 1961) but missing on Pukapuka (McCormack 2004).

**Biology.**—This social paper wasp is ubiquitous in open habitats on the Cook Islands but less common than *P. olivaceus*. The species builds free hanging nests in bushes and trees.

**Specimens examined.**—Rarotonga: Arorangi, Raemaru trail, 50 m (21 14'06"S 159 49'19"W), 3 ♀, 17.ix.2004; Arorangi, upper beach, 5 m (21 12'45"S 159 49'39"W), 1 ♀, 20.ix.2004; Mangaia: Ivirua, on Makatea, 30 m (21 55'15"S 157 53'21"W), 3 ♀, 22.ix.2004; 4 ♀, 27.ix.2004; S Ivirua, on Makatea, 30 m (21 55'52"S 157 52'42"W), 1 ♀, 26.ix.2004.

*Polistes olivaceus* (de Geer, 1773)

**Distribution.**—East Africa, South Asia, Australia and common on archipelagos of the Indian and Pacific ocean (Carpenter 1996). Probably introduced to the Cook Islands.

Very common in the Cook Islands but missing in Tongareva (= Penrhyn) and Pukapuka (Krauss 1961, McCormack 2004).

**Biology.**—This social paper wasp is ubiquitous in open habitats on the Cook Islands and builds free hanging nests in bushes and trees.

**Specimens examined.**—Rarotonga: Arorangi, upper beach, 5 m (21°14'20"S 159°49'40"W), 7 ♀, 15.ix.2004; 1 ♀, 18.ix.2004; Arorangi, Raemaru trail, 50 m (21°14'06"S 159°49'19"W), 1 ♀, 17.ix.2004; Arorangi, fallow land, 10 m (21°12'54"S 159°49'42"W), 2 ♀, 19.ix.2004; Arorangi, upper beach, 5 m (21°12'45"S 159°49'39"W), 1 ♀, 20.ix.2004; 2 ♀, 4.x.2004; Mangaia: Ivirua, on Makatea, 30 m (21°55'15"S 157°53'21"W), 1 ♀, 22.ix.2004; S Ivirua, on Makatea, 30 m (21°55'52"S 157°52'42"W), 1 ♀, 26.ix.2004.

**Ampulicidae***Ampulex compressa* (Fabricius, 1781)

**Distribution.**—Ethiopia, Kenya, Tanzania, Arabian Peninsula, Madagascar, Seychelles, Réunion, Mauritius, India, Sri Lanka, Bangladesh, Singapore, south China, Indonesia, Philippines, Australia, New Caledonia (Pulawski 2003). To help control the cockroach *Periplaneta americana* (Linnaeus, 1758) between 1955 and 1958 its parasitoid *A. compressa* was introduced to Rarotonga from Hawaii, where it had been introduced from New Caledonia in 1941 (Walker & Deitz 1979, McCormack 2004). The conspicuous sphecid has not been observed for many years and might be extinct.

**Biology.**—All *Ampulex* species hunt cockroaches and nest in preexisting cavities (Bohart & Menke 1976).

**Specimens examined.**—

**Sphecidae***Sceliphron caementarium* (Drury, 1773)

**Distribution.**—The origin of this species is North and Central America, now ranging worldwide (Pulawski 2003). Introduced to the Cook Islands. Common on Rarotonga (McCormack 2004) and also present on Aitutaki (Krauss 1961).

**Biology.**—Species of *Sceliphron* construct free clay nests on rocks, houses or wood and provision the cells with spiders (Bohart and Menke 1976). This synanthropic species is common on Rarotonga where it can be frequently observed flying along walls and roofs even in the centre of the capital Avarua.

**Specimens examined.**—Rarotonga: Arorangi, fallow land, 10 m (21°12'54"S 159°49'42"W), 8 ♂, 19.ix.2004; Arorangi, upper beach, 5 m (21°12'45"S 159°49'39"W), 1 ♂, 20.ix.2004.

*Sceliphron laetum* (F. Smith, 1856)

**Distribution.**—India, Indonesia, New Guinea, Australia, New Zealand, Guam, Mariana Islands (Pulawski 2003). First record for the Cook Islands of this introduced species. Like other species of *Sceliphron* *S. laetum* is easily introduced to islands by ships. According to Krombein (1949b), this species accompanied a ship that sailed over 3,000 km from the Solomons to Guam in 1945 and established a colony there.

**Biology.**—Species of *Sceliphron* construct free clay nests on rocks, houses or wood and provision the cells with spiders (Bohart and Menke 1976). This species is less common on Rarotonga than *S. caementarium* and only known from one locality.

**Specimens examined.**—Rarotonga: Arorangi, fallow land, 10 m (21°12'54"S 159°49'42"W), 2 ♀, 2 ♂, 19.ix.2004.

**Crabronidae***Pison* sp. 1

**Distribution.**—About half of the 196 worldwide known species of the genus *Pison* occur in Australia and the Pacific

region with 26 of them known from Oceania (Pulawski 2003). The genus is badly in need of revision before the two species found on the Cook Islands can be identified. McCormack (2004) listed this bigger species as *P. tahitense* (de Saussure 1867) but it differs from it in the following points: mesopleuron sparsely punctate, with punctures several diameters apart (subcontiguous in *P. tahitense*), the propodeal posterior surface is punctate (transversely rugulosopunctate in *P. tahitense*) and the wings are translucent (moderately infumate in *P. tahitense*) (Pulawski pers. comm.). Krauss (1961) mentions *P. hospes* (F. Smith 1879) from Aitutaki. This species is known from Singapore, Philippines, New Guinea, Micronesia, Hawaii, Fiji, Tonga, Samoa, Marquesas and Society Islands (Yasumatsu 1953, Pulawski 2003). The two species I collected on Rarotonga and Mangaia, about 250 km south of Aitutaki, are clearly different from *P. hospes* (Pulawski pers. comm.). Due to the difficult taxonomic situation in this genus the identity of *P. hospes* reported by Krauss (1961) needs to be confirmed. Beside *P. hospes* and *P. tahitense* three more *Pison* species are known to occur in regions adjacent to the Cook Islands: *P. iridipenne* F. Smith, 1879 (Australia, New Guinea, Philippines, Hawaii, Micronesia, Fiji, Samoa, Society Islands, Tuamotu Archipelago, Marquesas), *P. ignavum* R. Turner, 1908 (Australia, New Guinea, Philippines, Taiwan, Micronesia, New Caledonia, Fiji, Samoa, Society Islands, Marquesas) and *P. impunctatum* R. Turner, 1912 (New Guinea, Society Islands, Marquesas) (Yasumatsu 1953, Pulawski 2003). The latter species was not available for comparison and the former two are different from the species collected (Pulawski pers. comm.). Both species collected during the survey are probably indigenous to the Cook Islands.

Previously known from Rarotonga (1999; iii.2003, leg. McCormack), Mangaia and Pukapuka (ii.2004, leg. McCormack) (McCormack 2004).

**Biology.**—Species of *Pison* construct either free clay cells or partitions holes in timber and provision the cells with spiders (Krombein 1949b).

**Specimens examined.**—Rarotonga: Arorangi, Raemaru trail, 50 m (21°14'06"S 159°49'19"W), 1 ♀, 17.ix.2004; Mangaia: S Ivirua, on Makatea, 30 m (21°55'52"S 157°52'42"W), 15 ♀, 26.ix.2004; Ivirua, on Makatea, 30 m (21°55'15"S 157°53'21"W), 6 ♀, 22.ix.2004; 1 ♀, 27.ix.2004.

### *Pison* sp. 2

**Distribution.**—For general comments on the genus see previous species. First record of this smaller species for the Cook Islands. Probably indigenous.

**Biology.**—See previous species.

**Specimens examined.**—Rarotonga: Arorangi, Raemaru trail, 50 m (21°14'06"S 159°49'19"W), 3 ♀, 3 ♂, 17.ix.2004; Arorangi, upper beach, 5 m (21°12'45"S 159°49'39"W), 1 ♀, 20.ix.2004; 4 ♀, 21.ix.2004.

### *Tachysphex fanniensis fanniensis* Cheesman, 1928

**Distribution.**—New Caledonia, Loyalty Islands, Society Islands, Tuamotu Archipelago, Marquesas. The subspecies *T. f. howeanus* Pulawski, 1977 is only known from Lord Howe Island and *T. f. corallinus* Pulawski, 1977 occurs on the north and east coast of Australia, New Guinea and the Solomon Islands (Pulawski 1977). A female was collected in 1925 on a ship about 750 km SE of Pitcairn flying over a bulwark (Pulawski 1977). Obviously *T. f. fanniensis* can be easily introduced to other islands. Indigenous to the Cook Islands.

Earlier records are from Rarotonga (1977, 1979, leg. Krauss; ii.2003, leg. G. McCormack) and Mauke (1976, leg. Krauss) (McCormack 2004).

**Biology.**—This species is very common on sandy and rocky parts of the upper beach where it nests in the ground or in existing cavities of rocks. It can also be



frequently found in sparsely vegetated places further inland. Females prey upon cockroaches which sit exposed on leaves (Pulawski 1977). Males often visit the introduced Mexican Fire-Plant (*Euphorbia cyathophora* J.A. Murray) (Euphorbiaceae) for nectar.

*Specimens examined.*—Rarotonga: Arorangi, upper beach, 5 m (21°14'20"S 159°49'40"W), 8 ♀, 12 ♂, 15.ix.2004; Arorangi, Raemaru trail, 50 m (21°14'06"S 159°49'19"W), 2 ♂, 17.ix.2004; Arorangi, upper beach, 5 m (21°12'45"S 159°49'39"W), 3 ♀, 7 ♂, 20.ix.2004; 1 ♂, 21.ix.2004; 1 ♀, 2 ♂, 4.x.2004; Mangaia: Ivirua, Taro gardens, 30 m (21°55'20"S 157°53'53"W), 1 ♀, 10 ♂, 23.ix.2004.

### Megachilidae

#### *Lithurgus (Lithurgus) scabrosus* (F. Smith, 1859)

*Distribution.*—India, Indonesia, New Guinea and many Pacific Islands eastwards up to Tahiti (Michener 1965, Snelling 2003). Due to their nesting in wood these bees have an excellent ability to cross water barriers, e.g. on ships (Michener 1965). Probably introduced to the Cook Islands by ancient Polynesians.

Previous records are from Rarotonga (iii.1979, leg. N.L.H. Krauss) and Aitutaki (1977, leg. N.L.H. Krauss) (McCormack 2004).

*Biology.*—Six of the seven collected specimens carry the phoretic mite *Chaetodactylus ludwigi* (Trouessart, 1904), some of them in large amounts. This mite is known from *Lithurgus* species from Madagascar, India, Java, New Caledonia, Moorea Island near Tahiti and Eastern Caroline Islands (Fain and Pauly 2001). I found *L. scabrosus* nesting in decaying wooden poles and like Pauly & Munzinger (2003) I observed a female visiting an *Ipomoea* species – Coastal Morning-Glory (*Ipomoea littoralis* Blume) (Convolvulaceae). Species of this subgenus are known to be oligoleges of Malvaceae (such as the widely distributed *Hibiscus*) (Snelling 2003) and Convolvulaceae (such as *Ipomoea pes-caprae* (L.) Sweet,

a widely distributed plant on pantropical seashores) (Pauly et al. 2001).

*Specimens examined.*—Rarotonga: Arorangi, upper beach, 5 m (21°12'45"S 159°49'39"W), 2 ♀, 20.ix.2004; Mangaia: S Ivirua, on Makatea, 30 m (21°55'52"S 157°52'42"W), 1 ♀, 26.ix.2004; Ivirua, on Makatea, 30 m (21°55'15"S 157°53'21"W), 4 ♀, 27.ix.2004.

#### *Megachile (Callomegachile) umbripenis* F. Smith, 1853

*Distribution.*—Widely distributed in Southeast Asia and large parts of the South Pacific (Krombein 1950, Snelling 2003). In Hawaii it was present as early as mid-19<sup>th</sup> century suggesting an introduction by Polynesians prior to European arrival (Snelling 2003). Probably introduced to the Cook Islands by ancient Polynesians (Pauly and Munzinger 2003).

Previous records are from Rarotonga (iii.1979, leg. N.L.H. Krauss; 1999, leg. British Executive Service Overseas), Atiu (1976, leg. N.L.H. Krauss), Aitutaki (1960, 1977, leg. N.L.H. Krauss; Krauss 1961) and Pukapuka (ii.2004, leg. G. McCormack) (McCormack 2004).

*Biology.*—One female and three males carry some phoretic mites. This species nests in all kinds of cavities of suitable size but with a preference for wood. Plant resins are used to line the nest cells (Snelling 2003). This species is perhaps oligolectic on Fabaceae. The few observed females frequently visit the native Beach Pea (*Vigna marina* (Burm.)) Males regularly visit the flowers of the introduced Mexican Fire-Plant (*Euphorbia cyathophora* J.A. Murray) (Euphorbiaceae) for nectar.

*Specimens examined.*—Rarotonga: Arorangi, upper beach, 5 m (21°14'20"S 159°49'40"W), 15 ♂, 15.ix.2004; 1 ♀, 5 ♂, 18.ix.2004; Arorangi, fallow land, 10 m (21°12'54"S 159°49'42"W), 1 ♀, 19.ix.2004; Arorangi, upper beach, 5 m (21°12'45"S 159°49'39"W), 2 ♀, 3 ♂, 20.ix.2004; 3 ♂, 21.ix.2004; Mangaia: Ivirua, on Makatea, 30 m (21°55'15"S 157°53'21"W), 1 ♂, 22.ix.2004; S

Ivirua, on Makatea, 30 m (21°55'52"S 157°52'42"W), 1 ♀, 1 ♂, 26.ix.2004.

*Megachile (Eutricharaea) sp. 1*

*Distribution*.—From the Australian and South Pacific region 66 taxa of the subgenus *Eutricharaea* are described that can be divided into three groups (Michener 1965). This small species belongs to group A as defined by Michener (1965). It comprises 36 taxa that are badly in need of revision before the species can be identified. The male is characterised by a mandible with an inferior basal projection, front coxa with apical spine, anterior tarsus slightly broadened and carina of sixth tergum with median emargination almost obscured by coarse serration. *Eutricharaea* is widely distributed in the South Pacific with at least some species indigenous to its islands. First record for the Cook Islands of this possibly indigenous species.

*Biology*.—The males were patrolling the upper beach over sparsely vegetated areas covered with the native Beach Pea (*Vigna marina* (Burm.)) (Fabaceae). Most species of the genus *Megachile* make nest cells from pieces cut from leaves of plants (Michener 1965); others line their cells with plant resins (Michener 2000).

*Specimens examined*.—Rarotonga: Arorangi, upper beach, 5 m (21°12'45"S 159°49'39"W), 1 ♀, 4 ♂, 20.ix.2004; 3 ♂, 21.ix.2004; 3 ♂, 4.x.2004.

*Megachile (Eutricharaea) sp. 2*

*Distribution*.—As for the previous species, this one belongs to group A of Michener (1965). This species is unusually large (female 11–13 mm, male 10–12 mm) for a member of group A. The male is characterised by a mandible without an inferior basal projection, front coxa with short apical tubercle, anterior tarsus unmodified and carina of sixth tergum with large median emargination. For general comments on the distribution of *Eutrichar-*

*aea* see previous species. First record for the Cook Islands. Perhaps introduced.

*Biology*.—One male carries a few individuals of a phoretic mite. For data on nesting see previous species. This species is very probably oligolectic on Fabaceae. The females can be regularly observed to collect pollen on the native Beach Pea (*Vigna marina* (Burm.)) and sometimes on the introduced Streaked Rattlepod (*Crotalaria pallida* Aiton).

*Specimens examined*.—Rarotonga: Arorangi, upper beach, 5 m (21°14'20"S 159°49'40"W), 1 ♀, 15.ix.2004; Arorangi, upper beach, 5 m (21°12'45"S 159°49'39"W), 14 ♀, 3 ♂, 20.ix.2004; 11 ♀, 5 ♂, 21.ix.2004; 5 ♀, 3 ♂, 4.x.2004; Mangaia: Ivirua, on Makatea, 30 m (21°55'15"S 157°53'21"W), 6 ♀, 2 ♂, 22.ix.2004; 1 ♀, 2 ♂, 27.ix.2004; Ivirua, Taro gardens, 30 m (21°55'20"S 157°53'53"W), 1 ♀, 1 ♂, 23.ix.2004.

## Apidae

*Apis mellifera* Linnaeus, 1758

*Distribution*.—Now distributed worldwide and introduced to the Cook Islands. It probably occurs on all larger islands and is known from Rarotonga, Mangaia, Aitutaki and Atiu and definitely missing on Tongareva (= Penrhyn) and Pukapuka (Krauss 1961, McCormack 2004).

*Biology*.—The honeybee is highly social and polylectic. Beside the hives of beekeepers it can build nests in hypergaecic cavities like hollow trees.

*Specimens examined*.—

*Ceratina (Neoceratina) dentipes* Friese, 1914

*Distribution*.—Japan, southeast Asia, Australasia and the West Pacific. The Cook Islands are far outside of the known distribution of *C. dentipes* and the subgenus *Neoceratina* on the whole (Michener 1965, Hirashima 1971). The species is recorded for the first time on the Cook Islands and is surely introduced.

*Biology*.—The species is known to build nests in pithy stems. Nesting biology is

Table 1. Distribution of bees and wasps for each island in the Cook Islands. Data about island type, land area and maximum elevation after Hein et al. (1997). Codes for islands and abbreviations are as follows: PN: Penrhyn, RK: Rakahanga, MH: Manihiki, PK: Pukapuka, NS: Nassau, SW: Suvarrow, PL: Palmerston, AK: Aitutaki, MN: Manuae, MT: Mitiaro, TK: Takutea, AT: Atiu, MK: Mauke, RR: Rarotonga, MG: Mangaia; A: Atoll, R: Reef Island, M: Makatea, V: High Volcanic Island, n.a.: no data available.

	Northern Cook Islands						Southern Cook Islands								
	PN	RK	MH	PK	NS	SW	PL	AK	MN	MT	TK	AT	MK	RR	MG
Island type	A	A	A	A	R	A	A	A/V	A	M	R	M	M	V	M
Land area (km <sup>2</sup> )	9.8	3.9	5.4	3.8	1.1	0.4	1.1	18.0	5.8	30.0	1.4	29.0	18.0	67.0	51.0
Max. elevation (m)	low	low	5	6	9	low	low	124	9	11	6	70	24	653	169
<b>Species</b>															
<i>Chrysis</i> spec.														X	
<i>Anterhynchium rufipes</i>								X				X		X	X
<i>Delta esuriens okinawae</i>														X	X
<i>Pachodynerus nasidens</i>				X				X				X		X	X
<i>Parodynerus bicinctus</i>								X		X		X		X	X
<i>Polistes jokahamae</i>								X				X		X	X
<i>Polistes olivaceus</i>														X	X
<i>Ampulex compressa</i>														X	
<i>Pison</i> spec. 1				X				X						X	X
<i>Pison</i> spec. 2														X	
<i>Sceliphron caementarium</i>								X						X	
<i>Sceliphron laetum</i>														X	
<i>Tachysphex f. famiensis</i>													X	X	X
<i>Apis mellifera</i>								X				X		X	X
<i>Ceratina dentipes</i>														X	
<i>Lithurgus scabrosus</i>								X						X	X
<i>Megachile umbripennis</i>				X				X				X		X	X
<i>Megachile</i> spec. 1														X	
<i>Megachile</i> spec. 2														X	X
Total species no.	n.a.	n.a.	n.a.	3	n.a.	n.a.	n.a.	9	n.a.	1	n.a.	6	1	19	12

analysed in detail by Okazaki (1992). The bee was found nesting in twigs in a small forest clearing in the interior of Rarotonga and on the upper part of the beach where it was flying above the creepers of the Beach Pea (*Vigna marina* (Burm.)) (Fabaceae).

*Specimens examined.*—Rarotonga: Arorangi, Raemaru trail, 50 m (21° 14' 06" S 159° 49' 19" W), 5 ♀, 17.ix.2004; Arorangi, upper beach, 5 m (21° 12' 45" S 159° 49' 39" W), 2 ♀, 21.ix.2004.

DISCUSSION

*Fauna and biogeography of the Aculeata of the Cook Islands.*—Information about the bee and wasp fauna is only available for seven of the fifteen Cook Islands (Table 1). No records exist for the islands of Palmerston, Manuae and Takutea in the Southern Group and Penrhyn, Manihiki, Rakahanga,

Nassau and Suvarrow in the Northern Group. During my three weeks' stay on Rarotonga and Mangaia six species were recorded for the first time (*Pison* sp. 2, *Sceliphron laetum*, *Ceratina dentipes*, *Megachile* sp. 1, *M. spec. 2*) adding up to a total of 19 species of bees and aculeate wasps currently known from the Cook Islands. Except for the probably extinct *Ampulex compressa* and *Chrysis* sp. all previously collected species were recorded again. Among the newly recorded species are the conspicuous wasp *Sceliphron laetum* and the large and common bee *Megachile* sp. 2. This is a clear sign that further investigations especially on the outer islands will probably lead to the discovery of additional species.

From their biology and distribution it is concluded that probably only three species



are definitely indigenous to the Cook Islands: *Anterhynchium rufipes*, *Parodynerus bicinctus*, *Tachysphex fanuiensis*. All of them are widely distributed in the tropical Pacific. Three more species (*Pison* sp. 1, *Pison* sp. 2, *Megachile* sp. 1) might be indigenous or even endemic because many of their relatives are known to be restricted to other Pacific islands (Yasumatsu 1953, Michener 1965). But their status remains uncertain due to the lack of revisions. Of the remaining 13 species 11 were accidentally introduced. The origin of eight species is in southeast Asia, two were introduced from the Americas and the provenance of *Chrysis* spec. is unknown. All these species build their nests overground in pre-existing cavities, dead wood and pithy stems, construct free clay nests or free hanging paper nests. The only exception is the cuckoo wasp *Chrysis* sp. that very probably parasitises a wasp species with hypergaecic nests. Thus, the nests are easily transported and species have been carried to various islands (Michener 1965). Of the six possibly indigenous species five build overground nests, too, and only *T. fanuiensis* is a ground nester. In addition to the honeybee only the digger wasp *A. compressa* was intentionally introduced to control the cockroach *Periplaneta americana* (Walker and Deitz 1979). With increasing tourism and trade accidental introductions of additional species can be expected in the future.

For the comparatively well investigated islands Pukapuka, Aitutaki, Mangaia and Rarotonga a positive relationship exists between island size and number of species (Table 1) as predicted by the theory of island biogeography (MacArthur and Wilson 1967). But this relationship is probably artificial and caused by accidental introductions. Except for the very touristic Aitutaki the other three islands show a correlation of species diversity and intensity of traffic that facilitates introductions. While the intensity of faunistic surveys on Aitutaki is low compared with the aforementioned islands further inves-

tigation might show that the real number of species on this island is much higher than the nine recorded species and that it would fit into this scheme as well. A lack of correlation between species diversity and size of an island could also be predicted from the low number of (probably) indigenous species that indicates an under-saturation of its fauna, probably due to their isolation.

*Biogeography of the aculeate fauna of Pacific islands.*—The biogeography of the bee and wasp fauna of the Cook Islands can only be understood in a Polynesian and Pacific context. Traditionally the Pacific islands, excluding those close to the Americas, Asia and Australia, are divided, originally on the basis of their indigenous aboriginal peoples, into Polynesia, Micronesia and Melanesia (Crocombe 2001). This division serves sufficiently for biogeographic purposes (Fosberg 1984) and is used here, too. Good accounts of the bees and wasps are available for very few of the Pacific islands or island groups (Table 2). Therefore, biogeographic conclusions on their island faunas must be regarded as tentative except at the broadest level.

From Polynesia faunistic data on bees and wasps are available for seven archipelagos including New Zealand. The most comprehensive investigations were made on six islands groups of Micronesia whilst Melanesia is poorly investigated (Table 2). As demonstrated for Micronesia (Krombein 1950) there is a general tendency that the number of species as well as endemics of Pacific islands declines with increasing distance from Australian and Asian mainland and the Indo-Australian islands. Thus, most of the remote archipelagos of Polynesia possess a depauperate aculeate fauna consisting of widespread species. This, too, applies to the indigenous aculeate fauna of the Cook Islands that is extremely depauperate and only consists of three wasp species widely distributed in Polynesia and other parts of Oceania. Due to a lack of taxonomic revisions the

Table 2. Numbers of (sub)species of aculeate wasps and bees (including introduced species) in Polynesia and adjacent islands of Melanesia and Micronesia (n.a.: no data available; (): species numbers for some families not available).

	Apidae	"Sphecidae"	Vespidae	Pompilidae	Scoliidae	Mutillidae	Tiphiidae	Chrysididae	total	endemic	introd.
<b>Polynesia</b>											
Hawaii <sup>1)(2)(3)</sup>	75	60	127	4	1	-	5	3	275	76%	24%
Samoa <sup>4)(5)(6)</sup>	13	9	3	1	-	-	-	-	26	n.a.	n.a.
Marquesas Is. <sup>7)(22)(23)</sup>	1	7	4	-	-	-	-	-	12	-	n.a.
Tuamotu Is. <sup>22)(23)</sup>	2	1	3	-	-	-	-	-	6	-	n.a.
Society Is. <sup>22)(23)(25)</sup>	3	11	7	-	-	-	-	-	21	5%	n.a.
Cook Is.	6	6	6	-	-	-	-	1	19	-	84%
New Zealand <sup>8)(27)(28)</sup>	>40	23	n.a.	11	n.a.	n.a.	n.a.	n.a.	(74) (±80%)	n.a.	n.a.
<b>Melanesia</b>											
Solomon Is. <sup>9)(10)</sup>	32	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	(32)	n.a.	n.a.
Vanuatu <sup>11)(12)(13)</sup>	14	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	(14)	n.a.	n.a.
New Caledonia <sup>14)(21)(24)(26)</sup>	22	19	6	12	1	1	2	-	63	n.a.	n.a.
Fiji <sup>15)(16)</sup>	10	15	6	5	2	-	-	-	38	n.a.	n.a.
<b>Micronesia</b>											
Bonin Is. <sup>17)(29)</sup>	8	4	2	-	1	1	-	1	17	47%	6%
Northern Marianas <sup>18)(19)(20)</sup>	6	3	3	-	-	-	-	-	12	25%	42%
Southern Marianas <sup>18)(19)(20)</sup>	14	12	7	2	1	-	-	-	36	39%	42%
Carolines <sup>18)(19)(20)</sup>	16	21	5	2	3	1	-	-	48	50%	25%
Marshall Is. <sup>18)(19)(20)</sup>	2	8	1	-	-	-	-	-	11	-	55%
Gilbert Is. <sup>18)</sup>	-	1	-	-	-	-	-	-	1	-	100%

<sup>1)</sup>Snelling (2003), <sup>2)</sup>Daly & Magnacca (2003), <sup>3)</sup>Nishida (1994), <sup>4)</sup>Pauly & Munzinger (2003), <sup>5)</sup>Perkins & Cheesman (1928), <sup>6)</sup>Williams (1928), <sup>7)</sup>Williams (1932), <sup>8)</sup>Donovan (1983), <sup>9)</sup>Krombein (1949a), <sup>10)</sup>Krombein (1951), <sup>11)</sup>Cheesman (1936), <sup>12)</sup>Cheesman & Perkins (1939), <sup>13)</sup>Cheesman (1948), <sup>14)</sup>Pauly & Munzinger (2003), <sup>15)</sup>Williams (1947), <sup>16)</sup>Fullaway (1957), <sup>17)</sup>Yasumatsu (1955), <sup>18)</sup>Krombein (1949b), <sup>19)</sup>Krombein (1950), <sup>20)</sup>Tadauchi (1994), <sup>21)</sup>Callan (1990), <sup>22)</sup>Michener (1965), <sup>23)</sup>Cheesman (1928), <sup>24)</sup>Turner (1919), <sup>25)</sup>Menke (1979), <sup>26)</sup>Williams (1945), <sup>27)</sup>Harris (1987), <sup>28)</sup>Harris (1994), <sup>29)</sup>Yasumatsu (1936)

recorded species of *Pison* and *Megachile* (*Entricharaea*) are unidentifiable at present but they are probably not endemics of the Cook Islands. Exceptions are Hawaii with its highly endemic and species rich fauna that result from the adaptive radiation of genera like *Hylaeus* (*Nesoprosopis*) (60 species) and *Odynerus* (99 species) and the incompletely documented fauna of New Zealand. There is also a rapid eastwards loss of indigenous parasitic taxa of the families Scoliidae, Mutillidae, Tiphiidae and Chrysididae. They are all dependent on their hosts and thus have a limited potential for dispersal. Interestingly, this also seems to be true for the spider hunting Pompilidae.

These basic patterns are nowadays at least partly obscured by the number of

introduced species that often comprise up to 50% or more of the species known to occur on some archipelagos (Table 2). As a basis for the reconstruction of distribution patterns and to better understand the history of island colonization in the Pacific there is a need for further investigations of island faunas and taxonomic revisions of at least the most diverse and widely distributed genera of bees and sphecid wasps.

ACKNOWLEDGEMENTS

I am very much indebted to Gerald McCormack, Director of the Cook Islands Natural Heritage Project, for his constant support and for providing valuable background information about the bees and wasps recorded in the Cook Islands Biodiversity Database. Species identifications were carried out by (in alphabetical order) James Carpenter (New York), Michael

Ohl (Berlin), Wojciech Pulawski (San Francisco) and Michael Terzo (Gembloux), who also provided information about nomenclature and distribution. Field work was very much facilitated by the help of Ulrike Gigengack (Münster). The National Research Committee, Government of the Cook Islands, kindly permitted the collection of specimens on Rarotonga and Mangaia. A previous version of the manuscript was greatly improved by the comments of Wojciech Pulawski.

## LITERATURE CITED

- Bohart, R. M. and A. S. Menke. 1976. *Sphecid wasps of the world. A generic revision*. Berkeley, Los Angeles + London. ix + 695 pp.
- Callan, E. M. 1990. Sphecidae of New Caledonia. *Sphecos* 19: 22.
- Carpenter, J. M. 1996. Distributional checklist of species of the genus *Polistes* (Hymenoptera: Vespidae; Polistinae, Polistini). *American Museum Novitates* 3188: 1-39.
- Cheesman, L. E. 1928. A contribution towards the insect fauna of French Oceania. *Annals and Magazine of Natural History*, 10. Series 1: 169-194.
- Cheesman, L. E. 1936. Hymenoptera of the New Hebrides and Banks Islands. *Transactions of the Royal Entomological Society of London* 85: 169-195.
- Cheesman, L. E. 1948. Bees of New Guinea and the New Hebrides. *Annals and Magazine of Natural History*, 12. Series 1: 318-335.
- Cheesman, L. E., and R. C. L. Perkins. 1939. Halictine bees from the New Hebrides and Banks Islands (Hymen.). *Transactions of the Royal Entomological Society of London* 88: 161-171.
- Crocombe, R. 2001. *The South Pacific*. Institute of Pacific Studies, Suva (Fiji). 790 pp.
- Daly, H. V., and K. N. Magnacca. 2003. Hawaiian *Hylaeus* (*Nesoprotopis*) bees (Hymenoptera: Apoidea). *Insects of Hawaii* 17: 1-234.
- Donovan, B. J. 1983. Comparative biogeography of native Apoidea of New Zealand and New Caledonia. *Geojournal* 7: 511-516.
- Fain, A., and A. Pauly. 2001. Notes on phoretic deutonymphs of mites (Acari) associated with Old World Megachilidae and Anthophoridae (Insecta Hymenoptera), mainly from Madagascar. 1. Families Chaetodactylidae, Acaridae, Histiotomatidae and Winterschmidtidae (Astigmata). *Belgian Journal of Entomology* 3: 125-142.
- Fosberg, F. R. 1984. Phytogeographic comparison of Polynesia and Micronesia. Pp. 33-44 in: Radovsky, F. J., P. H. Raven and S. H. Sohmer, (eds.). *Biogeography of the tropical Pacific*. Honolulu.
- Fullaway, D. T. 1957. Checklist of the Hymenoptera of Fiji. *Proceedings of the Hawaiian Entomological Society* 16: 269-280.
- Giordani Soika, A. 1957. Biogeografia, evoluzione e sistematica dei vespidi solitari della Polinesia meridionale. *Bolletino del Museo Civico di Storia Naturale di Venezia* 10: 183-221.
- Harris, A. C. 1987. Pompilidae (Insecta: Hymenoptera). *Fauna of New Zealand* 12.
- Harris, A. C. 1994. Sphecidae (Insecta: Hymenoptera). *Fauna of New Zealand* 32.
- Hein, J. R., S. C. Gray, and B. M. Richmond. 1997. Geology and hydrogeology of the Cook Islands. In: Vacher, H. L. and Quinn, T. (eds.). *Geology and hydrogeology of carbonate islands. Developments in Sedimentology* 54: 503-535.
- Hirashima, Y. 1971. Subgeneric classification of the genus *Ceratina* Latreille of Asia and West Pacific, with comments on the remaining subgenera of the world (Hymenoptera, Apoidea). *Journal of the Faculty of Agriculture, Kyushu University* 16: 349-375.
- Kimsey, L. S. 1990. *The chrysidid wasps of the world*. Oxford. 652pp.
- Krauss, N. L. H. 1961. Insects from Aitutaki, Cook Islands. *Proceedings of the Hawaiian Entomological Society* 17: 415-418.
- Krombein, K. V. 1949a. Records of bees from the Solomon Islands with descriptions of new subspecies (Hymenoptera, Apoidea). *Bulletin of the Brooklyn Entomological Society* 44: 10-14.
- Krombein, K. V. 1949b. The aculeate Hymenoptera of Micronesia. I. Scolidae, Mutillidae, Pompilidae and Sphecidae. *Proceedings of the Hawaiian Entomological Society* 13: 367-410.
- Krombein, K. V. 1950. The aculeate Hymenoptera of Micronesia. II. Colletidae, Halictidae, Megachilidae, and Apidae. *Proceedings of the Hawaiian Entomological Society* 14: 101-142.
- Krombein, K. V. 1951. Additional notes on the bees of the Solomon Islands (Hymenoptera: Apoidea). *Proceedings of the Hawaiian Entomological Society* 14: 277-295.
- MacArthur, R. H. and E. O. Wilson. 1967. *The theory of island biogeography*. Princeton. 203 pp.
- McCormack, G. 2004. Cook Island biodiversity database: <http://www2.bishopmuseum.org/pbs/cookislands/>; last updated 6/2004.
- Menke, A. S. 1979. Three sphecid wasps previously unrecorded from Tahiti (Hymenoptera: Sphecidae). *Proceedings of the Entomological Society of Washington* 81: 303.
- Michener, C. D. 1965. A classification of the bees of the Australian and South Pacific regions. *Bulletin of the American Museum of Natural History* 130: 3-362 + 15 plates.
- Michener, C. D. 1979. Biogeography of the bees. *Annals of the Missouri Botanical Garden* 66: 277-347.
- Michener, C. D. 2000. *The bees of the world*. Baltimore. 913 pp.
- Nishida, G. N. (ed.) 1994. Hawaiian terrestrial arthropods checklist. 2nd edition. *Bishop Museum Technical Report* 4: iii + 287pp.



Okazaki, K. 1992. Nesting habits of the small carpenter bee, *Ceratina dentipes*, in Hengchun Peninsula, southern Taiwan (Hymenoptera: Anthophoridae). *Journal of the Kansas Entomological Society* 65: 190-195.

Pauly, A., R. W. Brooks, L. A. Nilsson, Y. A. Pesenko, C. D. Eardley, M. Terzo, T. Griswold, M. Schwarz, S. Patiny, J. Munzinger, and Y. Barbier. 2001. Hymenoptera Apoidea de Madagascar et des îles voisines. *Annales Sciences zoologiques, Musée royal de l'Afrique centrale, Tervuren* 286: 390pp + 16 colour plates.

Pauly, A., and J. Munzinger. 2003. Contribution à la connaissance des Hymenoptera Apoidea de Nouvelle-Calédonie et de relations avec la flore butinée. *Annales de Societe Entomologique de France* (N.S.) 39: 153-166.

Perkins, R. C. L. and L. E. Cheesman. 1928. Apoidea, Sphecoidea, and Vespoidea. Insects of Samoa, Part V. Hymenoptera, Fasc. 1: 1-32.

Pulwaski, W. J. 1977. A synopsis of *Tachysphex* Kohl (Hym., Sphecidae) of Australia and Oceania. *Polskie Pismo Entomologiczne* 47: 203-332.

Pulawski, W. J. 2004. Catalog of Sphecidae sensu lato: [http://www.calacademy.org/research/entomology/Entomology\\_Resources/Hymenoptera/sphecidae/Genera\\_and\\_species\\_PDF/introduction.htm](http://www.calacademy.org/research/entomology/Entomology_Resources/Hymenoptera/sphecidae/Genera_and_species_PDF/introduction.htm); last updated 11/2004.

Snelling, R. R. 2003. Bees of the Hawaiian islands, exclusive of *Hylaeus* (*Nesoprotopis*) (Hymenoptera: Apoidea). *Journal of the Kansas Entomological Society* 76: 342-356.

Tadauchi, O. 1994. Bees of the Mariana Islands, Micronesia, collected by the expedition of the Natural History Museum and Institute, Chiba (Hymenoptera, Apoidea). *Esakia* 34: 215-225.

Turner, R. E. 1919. On the Hymenoptera collected in New Caledonia. *Annals and Magazine of Natural History*, 9. Series 3: 229-240.

Walker, A. K. and L. L. Deitz. 1979. A review of entomophagous insects in the Cook Islands. *New Zealand Entomologist* 7: 70-82.

Williams, F. X. 1928. *Larriidae*. Insects of Samoa, Part V. Hymenoptera, Fasc. 1: 33-39.

Williams, F. X. 1932. The sphegoid wasps of the Marquesas Islands. *Bulletin of the Bishop Museum* 98: 149-153.

Williams, F. X. 1945. The aculeate wasps of New Caledonia, with natural history notes. *Proceedings of the Hawaiian Entomological Society* 12: 407-451.

Williams, F. X. 1947. Aculeate wasps of Fiji. *Occasional Papers of Bernice P. Bishop Museum* 18: 317-336.

Yasumatsu, K. 1936. Hymenoptera of the Bonin Islands. *Transactions of the Natural History Society of Formosa* 26: 356-363.

Yasumatsu, K. 1953. Sphecoidea of Micronesia. 4. Revision of the genus *Pison* Spinola. Part 1. *Journal of the Faculty of Agriculture, Kyushu University* 10: 133-150.

Yasumatsu, K. 1955. On the bee fauna of the Bonin Islands. *Nihon-Seibutsu-Chiri-Gakkai-kaiho* 16-19: 219-223.

## A Review of the New World Genera of Trichogrammatidae (Hymenoptera)

JOHN D. PINTO

Department of Entomology, University of California, Riverside, Riverside, CA 92521, USA  
john.pinto@ucr.edu

---

**Abstract.**—The 55 New World genera of Trichogrammatidae are reviewed and a key is provided for their identification. The family classification utilized recognizes two subfamilies and four tribes: Trichogrammatinae (Trichogrammatini) and Oligositinae (Paracentrobiini, Chaetostichini, and Oligositini). Four **new genera** are proposed, *Adelogramma*, *Pseuduscana*, *Thanatogramma*, and *Viggianiella*. Five generic group names are given renewed status. These include *Burksiella* De Santis, *Centrobiopsis* Girault, *Ceratogramma* De Santis, and *Zaga* Girault, at the genus level, and *Lutzimicron* Costa Lima, at the subgenus level. Four genera are placed in **synonymy**: *Uscanoidea* Girault (= *Gnorimogramma* De Santis), *Zaga* (= *Lathrogramma* De Santis), *Burksiella* (= *Parahispidophila* Yousuf and Shafee), and *Xenufens* Girault (= *Pseudoxenufens* Yoshimoto). Fifteen new or revised species combinations result from generic synonymy and resurrection. Nine **new species** described include *Adelogramma primum*, *Burksiella diana*, *Ceratogramma jeffersi*, *Lathromeris hesperus*, *Lathromeroidea exemplum*, *Lathromeroidea gerriphaga*, *Pseuduscana sola*, *Thanatogramma oweni*, and *Viggianiella tropica*.

---

The chalcidoid family Trichogrammatidae represents a ubiquitous group of insect-egg parasitoids that is among the most poorly known of Hymenoptera. Minute size, fragility and logistical problems associated with collecting and curating such insects are largely responsible for their uncharted taxonomy and biology (Pinto and Stouthamer 1994). Yet, since the benchmark family review by Doutt and Viggiani (1968) there has been advance in our understanding of the group. A large number of new genera have been added, generic concepts have been modified and there has been a significant increase in collections available for study. This work is an attempt to consolidate current knowledge associated with the New World genera of Trichogrammatidae. Included are a key and review of genera, and descriptions of new genera and species.

In addition, certain nominal genera are synonymized and others are returned to generic status.

Although poorly known everywhere, knowledge of New World trichogrammatids has lagged and continues to lag. The last comprehensive review of genera (Doutt and Viggiani 1968) reported only 28 in the New World, or about 40% of the total known at that time. This study recognizes 55 New World genera, over 60% of the current total of 88 extant genera. The geographic distribution of these genera is summarized in Table 1.

It is the generic level, where modest advances have been made, that is the focus of this study. Species taxonomy remains especially rudimentary. Of the 232 named New World species, over 40% belong to a single genus, *Trichogramma*, a group closely tied to biological control (Pinto 1999). Several other relatively large genera such as *Oligosita*, *Pseudoligosita*, *Mirufens*, and *Chaetostricha* have few or no species

---

Current address: P.O. Box 2266, Waldport, OR 97394, USA; (e-mail: john.pinto@ucr.edu)

named in the New World, although they are relatively diverse there. Other groups, such as *Burksiella*, *Zagella*, *Lathiromeroidea*, *Uscanoidea* and *Zaga* in particular, are especially speciose in the Western Hemisphere, yet remain almost completely unknown.

Historically, the greatest impediment to progress in trichogrammatid taxonomy has been the absence of adequate collections. Until recently, holdings of most genera have been restricted to types and, at best, a few badly curated specimens other than types. In many cases, the types themselves are in such poor condition that the taxa represented are unidentifiable. Most of the recent advances can be attributed to the marked increase in survey activity by parasitic hymenopterists in the last three decades. The University of California Riverside Collection has served as a primary depository for uncurated Trichogrammatidae resulting from much of this work (see Acknowledgments). Although material is received from all parts of the world, collections from both temperate and tropical areas of the Western Hemisphere have dominated. Except for types, limited historical material in various museums and certain literature records, this study is based almost totally on these recent accumulations.

Any attempt to review the trichogrammatid genera for an extensive region of the world deals with a moving target. The family is a long way from attaining taxonomic stasis and new genera are expected as collecting continues. Also, because the vast majority of species in the family remain undescribed, generic definitions and limits will be prone to revision for some time. It is hoped that reviewing the New World genera now will encourage and facilitate the work that remains. Although this review focuses on the New World for practical reasons, it should be emphasized that most of its genera also are extralimital in distribution (Table 1). Indeed, it is likely that certain genera known

only from the Western Hemisphere will be shown to have broader distributions once the family is more adequately sampled. Considering that large areas of the New World, especially in South America, remain poorly collected, the key to genus will be considered successful if 80–90% of the collections can be successfully identified.

## METHODS

*Collecting and curation.*—Trichogrammatidae are collected by a variety of methods. Unfortunately relatively few are taken directly from host, although *Trichogramma* and *Trichogrammatoidea* are exceptions because of association with biological control projects and frequent occurrence on hosts (Lepidoptera) which are easily detected and abundant in disturbed habitats. Most material, however, is removed from bulk arthropod samples taken in yellow pan traps (YPT), fine-meshed Malaise traps (MT), flight intercept traps (FIT), or sweep samples (SP). Noyes (1982) reviewed these methods for chalcidoid collecting. For this study most specimens collected were stored in 80% ethanol and placed in a refrigerator or freezer until they could be curated further.

Taxonomic studies of Trichogrammatidae require slide-mounted material and examination with the light microscope at magnifications up to at least 600 $\times$ . Specimens utilized here were mounted in Canada balsam following the techniques of Platner et al. (1998). Most were placed dorsoventrally on slides. For certain taxa lateral mounts were used as well. Slides were complemented by card-mounted individuals whenever possible to allow examination of color, body length and shape. Specimens to be carded were removed from ethanol and treated with hexamethyldisilazane (HMDS) to prevent shrivelling (Heraty and Hawks 1998). Scanning electron microscopy was used frequently to fully appreciate structure. For SEM work, specimens were taken from



Table 1. General geographic distribution of New World genera of Trichogrammatidae.

Genus <sup>1</sup>	North America	Central America	West Indies	South America	Extralimital
<i>Adelogramma</i>	X	X		X	
<i>Adryas</i>		X		X	
<i>Aphelinoidea</i>	X	X	X	X	X
<i>Bloodiella</i>				?	X
<i>Brachista</i>	X	X	X	X	
<i>Brachygrammatella</i>	X				X
<i>Brachyufens</i>	X		X		
<i>Burksiella</i>	X	X	X	X	X
<i>Centrobiopsis</i>	X				
<i>Ceratogramma</i>	X	X	X	X	X
<i>Chaetogramma</i>	X	X	X	X	X
<i>Chaetostricha</i>	X		X		X
<i>Doirania</i>	X			?	X
<i>Epoligosita</i>	X	X	X	X	X
<i>Haeckeliania</i>	X	X	X	X	X
<i>Hydrophylita</i>	X	X	X	X	X
<i>Ittys</i>	X	X	X	X	X
<i>Ittysella</i>	X				
<i>Lathromeris</i>	X	X		X	X
<i>Lathromeroidea</i>	X	X	X	X	X
<i>Megaphragma</i>	X	X	X	X	X
<i>Mirufens</i>	X	X		X	X
<i>Monorthochaeta</i>	X				X
<i>Nicolavespa</i>	X	X	X		
<i>Oligosita</i>	X	X	X	X	X
<i>Pachamana</i>		X		X	
<i>Paracentrobia</i>	X	X	X	X	X
<i>Paratrachogramma</i>	X	X		X	X
<i>Pintoa</i>	X	X	X	X	
<i>Poropoea</i>	X	X	X	X	X
<i>Prestwichia</i>	X				X
<i>Pseudoligosita</i>	X	X	X	X	X
<i>Pseuduscana</i>	X	X	X	X	X
<i>Pterandrophysalis</i>	X				X
<i>Pteranomalogramma</i>				X	
<i>Pterygogramma</i>	X	X	X	X	X
<i>Sinepalpigramma</i>	X	X		X	
<i>Soikiella</i>	X				X
<i>Thanatogramma</i>	X				
<i>Trichogramma</i>	X	X	X	X	X
<i>Trichogrammatella</i>		X	X	X	
<i>Trichogrammatoidea</i>		X	X	X	X
<i>Trichogrammatomyia</i>	X	X	X	X	X
<i>Tumidiclava</i>	X	X	X	X	X
<i>Tumidifemur</i>		X	X	X	?
<i>Ulfens</i>	X	X	X		X
<i>Uscana</i>	X	X		X	X
<i>Uscanella</i>			X		
<i>Uscanoidea</i>	X	X	X	X	X
<i>Uscanopsis</i>			X		
<i>Viggianiella</i>				X	
<i>Xenufens</i>	X	X	X	X	X
<i>Xiphogramma</i>	X				X
<i>Zaga</i>	X	X	X	X	X
<i>Zagella</i>	X			X	

ethanol or off of cards and similarly treated with HMDS (Nation 1983).

*Types.*—The deposition of primary types and paratypes of new species is indicated in the descriptions. To minimize the possibility of mixed type series paratype designations generally are restricted to topotypic material. Mixed series are a concern in the Trichogrammatidae where interspecific morphological differences are often minimal and may be lacking altogether (Pinto et al. 2003).

Types of type species were examined for the majority of nominal genera treated. Specifics are indicated in the text when necessary to justify proposed taxonomic changes.

*Generic key.*—The generic key is intended for identification of New World taxa only. Although both sexes are considered in the key, females will produce better results in most cases. Ideally both sexes will be available for identification. Females are known for all described genera. Males are known for all except *Pteranomalogramma*, *Sinepalpigramma*, *Uscanella* and *Viggianiella*. Because of strong sexual dimorphism, considerable intrageneric variation or anticipated character misinterpretation certain genera terminate in the key more than once. The key assumes the availability of cleared, slide-mounted specimens, and use of a light microscope with adequate magnifications.

*Generic reviews.*—A synopsis of each genus is provided. Included are a synonymy with all relevant names, a diagnosis, a summary of general distribution, comments on worldwide and New World diversity, a discussion of nomenclature and taxonomy, New World records, and host information. For most genera the diagnosis is based on females. For males,

only genitalic features are reported in many cases. It can be assumed that males do not differ from females for other characters unless indicated. Characters stressed in each diagnosis focus on those important for distinguishing the genus from similar taxa, and consequently are not homogeneous. References for original descriptions are not included in the Literature Cited unless cited in another context. This primary literature is referenced by Doutt and Viggiani (1968) and Noyes (2001, 2005).

The records for each genus include country and, for countries occupying considerable latitude and/or longitude, state, province or region as well. These additional categories are reported for Canada, The United States, Mexico, Brazil, Argentina and Chile. There is no attempt to provide detailed host information. Several published host records of trichogrammatids lack adequate documentation and are suspect. In this work host family or order is provided (with at least one reference) only if the record is considered trustworthy.

*Generic index.*—A formal index to genus is not provided. However generic treatments can be found in the text by assigned numbers which are based on order of presentation. These are given in the classification section below, and in the generic key.

*Species descriptions.*—Descriptions of new species are kept to a minimum in this work. Only nine are described. Included are type species of the four new genera, and five species which represent relatively distinctive sections of their genus. The species descriptions are included in the treatment of the appropriate genus. Sections for each new species treatment are

←

<sup>1</sup> The record of the Australasian genus *Brachyia* in the New World by De Santis (1997) is in error. See treatment of *Zagella* [48].

the description, types, etymology, distribution, material examined and comments. The material examined section also includes an abbreviated listing of the types. The comments section includes comparisons to related species when appropriate. Quantitative data are taken from the type series in most cases.

*Museums.*—Acronyms for museums referred to in the text follow N. Evenhuis and G. Samuelson (Abbreviations for Insect and Spider Collections of the World: <http://hbs.bishopmuseum.org/codens/codens-inst.html>). These are as follows: BMNH (Natural History Museum; London, UK), CAS (California Academy of Sciences), CNC (Canadian National Collection of Insects, Ottawa), DEZA (Dipartimento di Entomologia e Zoologia Agraria dell'Università, Portici), EMEC (Essig Museum of Entomology, U.C. Berkeley), HIC (Hymenoptera Institute Collection, University of Kentucky), INBC (Instituto Nacional de Biodiversidad [INBio], Costa Rica), INHS (Illinois Natural History Survey, Champaign), MACN (Museo Argentino de Ciencias Naturales "Bernardino Rivadavia"), MLPA (Museo de la Plata, Argentina), QM (Queensland Museum, Australia), MZCR (Museo de Zoología, Universidad de Costa Rica), NMNH (National Museum of Natural History, Washington D.C.), TAMU (Texas A&M University, College Station), UCDC (University of California, Davis), UCRC (University of California, Riverside).

#### ANATOMICAL STRUCTURE AND TERMINOLOGY

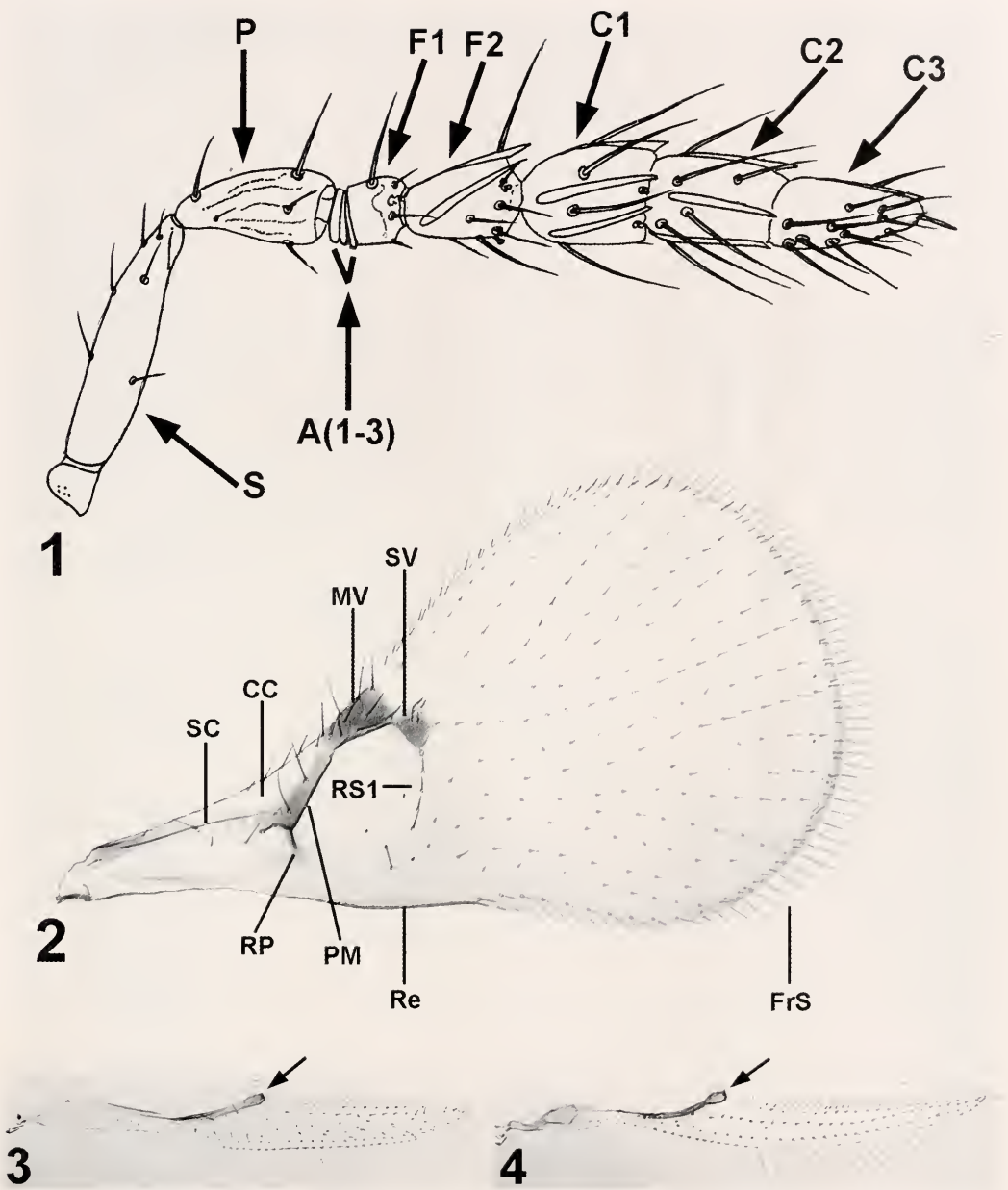
Anatomical terms for most general Hymenoptera structures follow Gibson (1997). Doult and Viggiani (1968) is utilized for terms associated with the fore wing. Those used for male genitalia follow Viggiani (1971) and Pinto (1999), and those applied to antennal sensilla are consistent with Pinto and Owen (2004). References to length and width of structures refer to maximum dimensions unless indicated.

Trichogrammatid structure has never been studied in detail and it largely remains an untapped resource to be exploited for infrafamilial systematics. One problem precluding facile utilization of structure obviously is the small size (usually < 1.0 mm) and fragility of these wasps. Slide-mounted material, so necessary to characterize antennae, wings and genitalia, generally precludes detailed study of core body parts. For this reason, slide mounts need to be complemented with SEM examination before morphological variation in this family is adequately understood. The following is a summary of the structures (with acronyms) characterizing the family and used for identifying and diagnosing genera.

*Head capsule* (Figs 163–166).—The head capsule is used minimally in this study. The extent of sclerotization of the head varies. In general, the head is poorly sclerotized except for the gena. However, a sclerotized plate may occur on the vertex and in a few groups the face also is well sclerotized. Subantennal grooves (**SAG**) are characteristic of most or all genera, whereas the presence of malar sulci (**MSL**) varies. A distinct clypeus (**CLY**) usually is present but there are exceptions. The placement of the toruli (**TOR**) on the face varies somewhat and can be useful in distinguishing certain genera.

*Antenna* (Fig. 1).—The antenna is of considerable importance in trichogrammatid systematics. Of primary use is the number and arrangement of flagellar segments (those apical to the scape [**S**] and pedicel [**P**]) which can vary from two (in male *Trichogramma*) to nine (in certain male *Ceratogramma*). The first segments (properly subsegments) beyond the pedicel are the ring-like anelli (**A**). There commonly are two anelli (**A1**, **A2**), although several genera have only one, and in *Ceratogramma* there are three (**A3**). In many cases **A2** is partially or almost completely fused to the following segment. The presence of a coeloconic sensillum on **A2** (visible medially)





Figs 1–4. 1, antenna, *Ceratogramma brasiliense* (♀). 2, fore wing, *Haeckeliania*. 3, hind wing *Ceratogramma masneri* (arrow to hamuli). 4, same, *Ufens*. See text (Anatomical Structure and Terminology) for explanation of acronyms.

identifies this segment (Fig. 10). Flagellomeres apical to the anelli are referred to as postanellar segments. They either are consolidated into a club (C) of one to five segments (C1–C5), or also partitioned into a funicle of one or two segments (F1, F2). When a funicle is present the club gener-

ally is one to three segmented, although a small fourth segment occurs in males of *Ufens*, *Mirufens* and some *Ceratogramma* (Fig. 60). In some cases deciding whether a segment represents a funicular or a club segment is difficult and somewhat arbitrary. Also, in certain taxa two or more of

the flagellomeres can be partially fused resulting in segment counts that vary with the surface viewed. The sutures separating flagellar segments also vary considerably in form. They may be transverse but, more commonly, are slightly to highly irregular resulting in noticeable segment asymmetry. This asymmetry results in segment length varying with the surface being viewed.

Because of their considerable size range, frequent partial or complete fusion and considerable asymmetry, segment number is often difficult to determine. Small segment size is especially problematic. Thus, in several genera such as *Zagella*, *Adryas*, and *Zaga* F1 or C1 is narrow, very short, transverse, and closely appressed to the following segment (F2 or C2). In these taxa, this segment is difficult to detect or may be confused with an anellus. Fortunately, in most cases F1 or C1 will bear one or more basiconic peg sensilla on its apical margin (Figs 5, 6); anelli never do. It often is the detection of these sensilla that signals the presence of a basal F1 or C1. Locating these segments is critical for generic identification. Although segments may also be partially fused, in this work segment number refers to completely divided segments unless indicated.

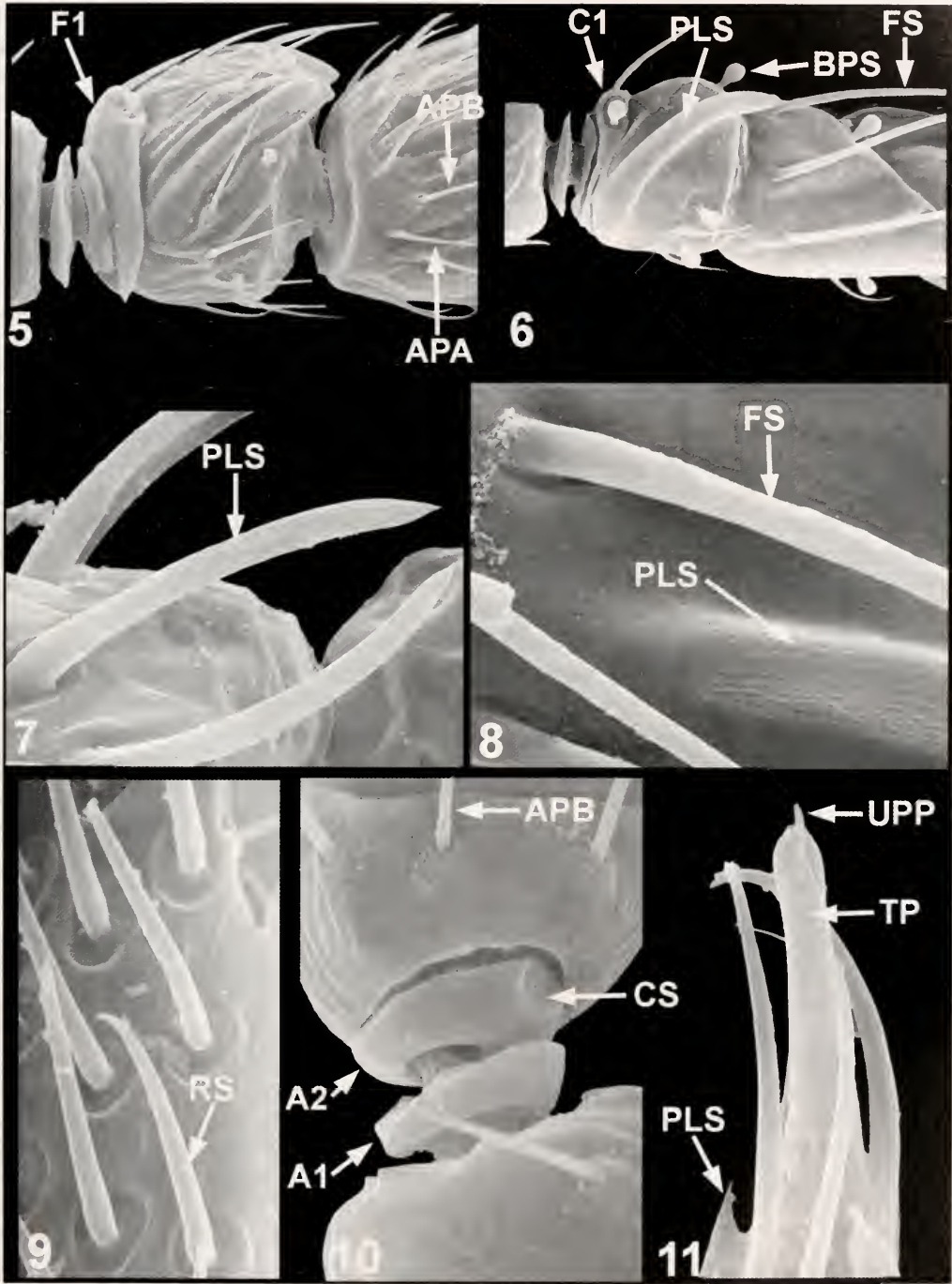
Because of their value in identification the distribution of antennal sensilla are reported in many of the generic diagnoses and species descriptions. Exemplars of the various sensilla associated with trichogrammatid antenna are given in Figs 5–11. Included are placoid sensilla (PLS), aporous sensillar trichodea B (APB), aporous setae A (APA), flagelliform setae (FS), recurved sensilla (RS), basiconic peg sensilla (BPS), uniporous pit pore sensilla trichodea D (UPP), and coeloconic sensilla (CS). These terms and acronyms (also utilized in Pinto and Owen 2004) follow, or are modifications of, those utilized for *Trichogramma* by Vincent and Goodpasture (1986), Olson and Andow (1993), and Pinto (1999). Most of these structures were

characterized after SEM study by Olson and Andow (1993). Their identification in most other genera is based simply on phenetic similarity to those in *Trichogramma*.

Regarding the distribution of sensilla on the flagellar segments: PLS, APB, APA, BPS, and FS can be found on any of the postanellar segments depending on the group. RS occur apicoventrally on the last club segment of females in certain genera. They may be numerous and comprise a distinct patch or 'micropilose region' as in *Trichogramma* (Fig. 34), or be represented by no more than two-three sensilla near the apex of the club as in certain *Adryas*. RS are similar to FS except they are shorter, recurved and have characteristic oblique surface grooves (Pinto and Owen 2004, Fig. 8). These grooves are not visible with the light microscope; consequently RS in most cases are tentatively identified by their length, position and curvature. A single CS occurs on A2 (Fig. 10) and one sometimes can be detected on F2. UPP occur singly at the apex of the club in females (Fig. 11); it is not clear if they are present in all genera.

In females of several genera the apex of the club is abruptly narrowed and prolonged into a terminal process (= apical process of Doult and Viggiani 1968, and Pinto and Owen 2004) of varying length (TP, Fig. 11). This structure is not to be confused with PLS which sometime extensively overlap the club apex (e.g. Fig. 89). When present, the terminal process usually extends considerably beyond the tip of the apical-most PLS and, as is typical of the female club in most genera without a process, bears the UPP at its apex.

In addition to presence or absence and density on various segments, sensilla shape and size also are useful taxonomically. The various setiform sensilla may vary considerably in length, and the BPS vary in shape from subglobose to narrow and fusiform. Also, the degree of attachment of the longitudinal PLS to the



Figs 5–11. Antennal sensilla. 5, *Zagella*. 6, *Lathromeroidea*. 7, *Soikiella occidentalis* (♂). 8, *Soikiella occidentalis* (♀). 9, *Trichogramma pretiosum* (♀). 10, *Tumidiclava*. 11, *Nicolavespa theresae* (♀). See text (Anatomical Structure and Terminology) for explanation of acronyms.



antennal surface varies. In most taxa they are attached almost their entire length with only the apex projecting beyond the surface (Fig. 6). However, these sensilla may be free of the surface over much of their length, and in males of certain genera (*Soikiella*, *Haeckeliania*, *Trichogrammatoidea*, *Adelogramma*), they are completely free, attached only at their base, and project from the antenna as thick, elongate spini-form structures (Fig. 7). Consequently they may be confused with FS, the most common setiform sensilla on the antenna. Unlike the relatively smooth and thin FS, however, these exerted PLS are thicker and retain their characteristically ridged and densely pitted surface (cf. Figs 6–8).

*Mouthparts*.—Relatively few features of the trichogrammatid mouthparts have been used in taxonomy. Among these are the number and structure of the mandibular teeth and the number of maxillary palpal segments. Mandibular dentition is difficult to determine on slide-mounted specimens. Most genera have a mandible with three-five serrations or teeth (Fig. 168). The mandibles are somewhat palmate in structure with the teeth arranged antero-posteriorly when the head is in a hypognathous position. In a small group of genera which includes *Trichogramma* there is a distinct anterior socketed tooth as well (Fig. 169). This appears to be analogous to the ventroapical socketed mandibular tooth found in Aphelinidae and Encyrtidae (Heraty and Schauff 1998). There typically are one or two maxillary palpal segments in trichogrammatids (Figs 172, 173). A peg-like or setiform sensillum accompanied by one-two setae usually occur at or near the apex of the terminal palpal segment. Although the palp may be quite small, only in one genus, *Sinepalpigramma*, is it entirely absent (Fig. 171). The palpal segment count may be critical for generic identification. A single segmented labial palp also occurs in Trichogrammatidae. Its size and other labial features vary in the

family but have yet to be studied adequately.

*Mesosoma*.—Except for the wings, relatively few characters of the mesosoma are used for identification. Among these (Figs 179–194) are the number of setae on the midlobe of the mesoscutum (MLM) and scutellum (SCT), shape and length of the propodeum (PPD), relative length of the metanotum (MTM), and presence or absence of the mesopleural suture (PS) and transepisternal sulcus.

There are one or two pair of setae on both the midlobe and scutellum of most genera (Figs 180, 184–187). All representatives of the Oligositini have a single pair on both structures. In all other groups at least the scutellum has two pair, although the anterior pair may be very small and difficult to see (Figs 184, 185). In a few cases (e.g. *Brachyufens*, Fig. 179) there are three pair of midlobe setae, and in one species of *Pterygogramma*, an anomaly in its genus as well as the family, the scutellum has six pair (Fig. 95). The number of setae on the midlobe generally is constant within genera, however exceptions occur (e.g. in *Adryas*, see Pinto and Owen 2004). The shape of the propodeum and its medial length relative to that of the metanotum often is reported. The central section of the propodeum may be undifferentiated or elevated and expanded posteriorly (propodeal disk, Figs 186, 187).

The presence of sutures and sulci on the mesosoma usually are difficult to detect in trichogrammatids without SEM examination. This is not only because of small body size but also because the relatively thin cuticle often reveals subsurface ridges that are easily confused with surface impressions. For example, what appears to be a pleural suture under the light microscope may only be the internal pleural ridge. Similarly, what appear on slides to be distinct axillae (AX) and axillulae (AXL) generally are not actually separated from the scutellum as distinct sclerites on the surface (Figs 190, 191). These and other

mesosomal structures have yet to be adequately evaluated for use in family taxonomy.

Except for occasional reference to tarsomere length, tibial/femoral spur structure, and overall shape, leg structure is used minimally. One important character however is the presence or absence of thorn-like spines on the dorsal surface of the foretibia. A spinose surface characterizes *Mirufens*, *Chaetostricha* and *Zaga* and helps separate them from similar genera (cf. Figs 175–178). A potential leg character which has not been adequately studied is the spatulate structures at the apex of the hind tibia (Fig. 174) and on tarsomeres I–III of the fore leg. A feature common to Chalcidoidea, these apparently modified setae were previously noted on the hind tibia of *Trichogramma* (Hung 1990), but they occur on the fore and hind legs of all trichogrammatid genera examined with SEM (Pinto, unpubl.). It is assumed that they are used in grooming.

*Mesosoma: wings.*—Fore wing shape, venation and discal setation vary considerably in the family. Figs 2 and 148 indicate those features utilized in the key and diagnoses. Wing length (FWL) is taken from the apex of the humeral plate to the wing apex; wing width (FWW) is the maximum width wherever it occurs. Both measurements exclude the fringe setae. The length of the longest fringe setae (FrS) is given as a fraction of FWW. The longest setae generally occur on the posteroapical margin. Reference is sometimes made to the retinaculum (Re), that section of the posterior wing margin which the hamuli of the hind wing (Figs 3, 4) hook on to.

Terms associated with fore wing venation include the subcostal (SC) (= submarginal), premarginal (PM) (= parastigma), marginal (MV) and stigmal (SV) veins. A small postmarginal vein is rarely present in trichogrammatids. The SV usually includes an apical enlargement or stigma and a constriction between the stigma and the MV. In several taxa the SV

is highly reduced and sessile to the MV or homogeneous its entire length (i.e. without a basal constriction). All veins are entirely confluent or the SC and PM may be disjunct from one another and the MV. The SV always is confluent with the MV. The PM has one or two campaniform sensilla at its apex (Fig. 158). PM length is taken from its base to the apical-most campaniform except in the few cases where this sensillum clearly lies basal to the vein's apex. The length of the MV is taken from base to apex. If it is confluent with the PM, its basal end is taken to be immediately beyond the apical-most campaniform sensillum. The length of the SV is determined by measuring the entire distance from the anterior border of the MV to the apex of the SV and then subtracting the apical width of the MV. In most cases the SV emanates abruptly from the posteroapical corner of the MV and the two veins are distinct (Fig. 2); in others such as *Trichogramma* the entire MV gradually curves away from the anterior wing margin to form the SV (Fig. 113). The latter is termed apically sinuate venation. Similarly, the MV may end abruptly at its base, or curve dramatically to meet the PM as in *Pachamama* (Fig. 103) (basally sinuate venation). The space between the wing margin and the PM and SC is the costal cell (CC).

A ratio which is used to help separate certain genera of Chaetostrichini is the distance from the large globose sensilla on the SV to the base of the MV divided by the length of the PM ( $SV + MV / PM$ , Fig. 161). The placement of these sensilla vary little if at all among genera and represent the apical-most reach of the venation in the wing membrane. This ratio reflects differences in the length of the MV vs PM but also in the angle between the SV and MV. A cuticular spur or radial process (RP) radiating from the base of the PM into the wing membrane (Fig. 2) is characteristic of several genera.

Setal density and arrangement on the fore wing disk are described for most

genera. The family often is characterized by the arrangement of discal setae into linear tracks (Fig. 2). Scattered setae usually occur between the tracks and if these are sufficiently dense the tracks themselves are difficult to discern (Fig. 102). In several genera, all discal setae are scattered and no linear arrangement is discernible (Fig. 105), or the linear tracks are restricted to a portion of the wing membrane. Several of the linear tracks have been named based on their position (Fig. 148). The most important for generic identification is the **RS1**, a track running posteriorly from the stigma. In several genera a distinct RS1 is absent. Appropriate figures should be consulted for interpreting terms relating to fore wing setal density in the descriptions and diagnoses. In general, Fig. 2 represents 'moderately densely setose', Figs. 102 and 105 illustrate 'densely setose', and Fig. 153 shows 'sparsely setose'.

The hind wing, although structurally simple, also may be useful for generic identification and diagnosis. Width, arrangement of discal setae, and fringe length vary. Discal setae may be present or absent, and if present either scattered or arranged in one to several complete or partial linear tracks (Figs 3, 4). The length of these tracks, when reported, is taken from the hamuli to their apex.

*Metasoma: non-genitalic features.*—Except for genitalia, metasomal characters have been all but ignored in the trichogrammatid literature, and relatively few are referred to here. In several genera the first metasomal (petiolar) tergum bears a transverse row of erect denticles on its posterior margin. This feature, easily seen with the SEM (Fig. 188), also is visible on slide-mounted specimens (Fig. 189). The metasomal terga normally are homogeneously sclerotized their entire length. In the oligositine subtribe Eteroligositina, however, the posterior half of certain terga are longitudinally striate (Pinto and Viggiani 2004) (Figs 187, 197). Modifications of terga VI and VII, restricted to males, occur in

a few groups (Figs 262–264). These consist of patches of modified cuticle or subcuticular tubiform structures. They are easily seen in slide-mounted specimens although their structure has yet to be studied. Metasomal sternal features restricted to males of Eteroligositina (Oligositini) were recently illustrated and discussed by Pinto and Viggiani (2004). The extent to which the apical sternum, or hypopygium, subtends the female ovipositor varies considerably in the family (Figs 195–197). Although hypopygial length usually can be determined on slide-mounted specimens, shape variation, also considerable, is more difficult to document.

*Metasoma: ovipositor.*—Ovipositor structure varies. Its length (**OL**) is reported in relation to the hind tibial length (**HTL**). Other variation, although considerable, has not been adequately studied. It appears to be of taxonomic value primarily at the intrageneric level.

*Metasoma: male genitalia.*—Male genitalia are of importance for both identification and classification of Trichogrammatidae (Viggiani 1971, 1984; Pinto 1997a, 1999). Terms are illustrated in Figs 198, 199. *Trichogramma* is used to demonstrate terminology because it possesses virtually all structures possible. In *Trichogramma*, as in several genera, the aedeagus (**ADG**) is distinct from the phallobase or genital capsule (**GC**) and is capable of independent movement. A pair of apodemes (**AAP**) extends anteriorly from the base of the aedeagus. Aedeagal length (**AL**), when reported relative to **HTL**, includes the apodemes; in several cases reference is made to the length of the genital capsule (**GL**). Independent movement of the aedeagus in *Trichogramma* and other trichogrammatines is assumed because its position relative to the genital capsule often varies in conspecifics, and the aedeagus is considerably narrower than the narrowest width of the capsule and distinctly separated from its lateral walls. This condition is referred to here as **Type 1 genitalia**



(Figs 198–223). In what presumably is the most generalized state (e.g. *Mirufens* and *Haeckeliania*; Figs 205, 209), the aedeagus lies within a trough-like capsule which, perhaps except for a membranous sheath, is completely open dorsally. In other genera (e.g. *Paratrachogramma*, *Trichogramma*; Figs 198, 210) this dorsal trough is partially closed above the aedeagus near the middle of the capsule delimiting a basal anterodorsal aperture (ADA). Closure is effected by a transverse band (Fig. 210) which may be prolonged posteriorly into a dorsal lamina (DLA) (Fig. 198). Ventroapically the genital capsule may be differentiated into lateral parameres (PAR), a medial intervolsellar process (IVP) and, between this process and the parameres, a pair of volsellae (VS). Digital spines commonly occur at the apex of the volsellae, and a ventral ridge (VR) may extend anteriorly from the IVP base or from that location if an IVP is absent. Parameres sometimes bear an apical spine, and in certain genera such as *Haeckeliania* and *Paratrachogramma* they are bifid apically.

In the majority of trichogrammatid genera, the aedeagus appears to be fused to the genital capsule to a varying degree and no longer is capable of independent movement. In these genera the position of the aedeagal apodemes, when present, does not vary relative to the capsule among conspecifics and the aedeagus is not clearly distinguished from the capsule at least not at its apex. This represents **Type 2 genitalia** (Figs 224–259). As indicated, the apodemes of the aedeagus often remain in this type of genitalia (e.g. Figs 224–227). Parameres and/or volsellae do (Fig. 233) or do not occur (Fig. 243). In the most extreme consolidation, the aedeagus and genital capsule are fused into a simple tubiform structure with no indication of additional genitalic parts (e.g. Figs 242–245). In this case, at most, a pair of setae occur ventrally (ventral setae) (e.g. Figs 247, 253).

In most genera with Type 2 genitalia, a relatively large aperture (ADA) opens

dorsally (Fig. 254). In others this aperture is considerably reduced and opens more anteriorly (Figs 258, 259). The former condition is termed **Type 2A genitalia**; the latter is **Type 2B**. In Type 2A genitalia parameres, volsellae and ventral setae may or may not be present; in Type 2B genitalia these structures never occur. In many instances taxa with 2A genitalia have only one pair of unarmed, small vestigial lobes apically (Fig. 228) and it often is difficult to determine if parameres or volsellae are represented; the decision often is based on position (medial and adjacent to the midline, or lateral). These vestigial structures are not easily observed with the light microscope.

Distinguishing between Type 1 and the most generalized state of Type 2 genitalia such as occurs in the Paracentrobiini and *Tumidiclava* (e.g. Figs 224–230) may cause confusion. In both cases aedeagal apodemes occur. However, unlike the condition in Type 1, in Type 2 taxa the genital capsule is indistinguishable from the aedeagus apically. Also, as indicated, in Type 2 groups the position of the apodemes in large series of specimens is never seen to vary relative to the capsule, suggesting that they do not move independently. The genitalia of *Soikiella* may represent an intermediate state between types 1 and 2. In this genus, the aedeagus can be distinguished from the capsule apically (Figs 212, 214), yet SEM examination shows what appear to be poorly sclerotized lateral connections (Fig. 213).

## CLASSIFICATION

Several tribal classifications of the Trichogrammatidae have been proposed in the past century (e.g. Girault 1912, 1918; Kryger 1918, Blood 1923, Viggiani 1971, Yousuf and Shafee 1988). All are phenetic and utilize few characters. Because a phylogenetic study of family relationships based on molecular evidence currently is underway (Owen et al., in prep.) this topic is not covered in detail here. The arrangement of genera below represents a modification of Viggiani's 1971 classification, the

most widely followed currently. It is based primarily on male genitalia.

Viggiani divided the family into two subfamilies and four tribes, Trichogrammatinae (Trichogrammatini, Paracentrobiini) and Oligositinae (Oligositini, Chaetostrichini). With exceptions, genitalic structure is the most generalized in the Trichogrammatini and the most reduced in the Oligositini. The other two tribes represent intermediate conditions. One feature defining subfamily is the presence (Trichogrammatinae) or absence (Oligositinae) of aedeagal apodemes. Within the Trichogrammatinae Viggiani separated the nominate tribe from the Paracentrobiini primarily by genitalic shape and dimensions of the anterodorsal aperture. In the Trichogrammatini the genital capsule is widest near the middle with an aperture of varying shape, whereas in the Paracentrobiini the capsule is subconical, widest at its base and the aperture is relatively short and transverse. Aperture size also was used to distinguish the Chaetostrichini from Oligositini within the Oligositinae. In the former it is relatively large and well defined; in the latter it is considerably reduced. The genera originally assigned to these tribes are given by Viggiani (1971, 1984).

The arrangement followed here does not purport to be strictly monophyletic. Some arrangement of genera is necessary and the one used hopefully is more heuristic than simple alphabetical presentation. It deviates from Viggiani's classification in the following respects: The Trichogrammatinae consists of a single tribe and includes all genera with Type 1 genitalia. Genera with Type 2 genitalia are treated as Oligositinae. *Soikiella*, with annectant genitalic structure, is placed in the Trichogrammatini. In addition to the Oligositini and Chaetostrichini, the Oligositinae includes the Paracentrobiini formerly in the Trichogrammatinae, as well as several genera with Type 2 genitalia originally treated by Viggiani as Trichogrammatini presumably because of the presence of

aedeagal apodemes. These genera are treated here as Chaetostrichini.

Generic membership of the Paracentrobiini (Type 2a genitalia) and Oligositini (Type 2b genitalia), with one exception (*Ufensia*), retains the criteria of Viggiani, whereas membership of the Trichogrammatini (Type 1 genitalia) and Chaetostrichini (Type 2a genitalia) changes considerably. The former two tribes appear to be monophyletic, whereas the latter two are paraphyletic at best. The compelling reason for deviating from Viggiani's classification is that the presence of aedeagal apodemes now is known to vary within genera (e.g. in *Aphelinoides*, *Chaetogramma*, *Burksiella*) thus negating their value for defining tribes and subfamilies. Removal of the Paracentrobiini from Trichogrammatinae allows recognition of a monophyletic Oligositinae, defined by the fusion of the aedeagus and genital capsule apically and often basally as well. Monophyly also is supported by the molecular evidence (Owen et al., in prep.).

Genera are presented in the text in alphabetical order within tribe/subtribe. A list of all trichogrammatid genera (except fossil groups) and the subfamily and tribal assignments recognized in this work follow. Only one tribe, the Oligositini, is further divided into subtribes. Numbers associated with genera refer to order of presentation in the text. Genera in brackets are not known from the New World and are not formally treated further. An asterisk (\*) following a genus name indicates that the male is unknown. These genera are tentatively incorporated into the classification based on characters correlated with type of male genitalia. Family-group characters and a discussion of generic relationships within tribal groups are given in the text immediately before the first New World genus treated in that category. For example, the taxonomy of the Trichogrammatinae: Trichogrammatini precedes the treatment of *Brachyufens*.

Trichogrammatinae. **Trichogrammatini.** [*Apseudogramma* Girault]\*, [*Asynacta* Förster]\*, [*Aus-*

*tralufens* Girault], [*Brachyia* Strand], *Brachyufens* Viggiani (1), *Ceratogramma* De Santis (2), [*Eutrichogramma* K. Lin]\*, *Haeckeliania* Girault (3), [*Hispidophila* Viggiani], *Hydrophylita* Ghesquière (4), [*Japania* Girault], *Mirufens* Girault (5), [*Neobrachista* Girault], [*Neobrachistella* Girault], [*Neocentrobia* Girault]\*, [*Neocentrobiella* Girault]\*, [*Oligositoides* Doutt], [*Ophioneuris* Ratzeburg], *Pachamama* Owen and Pinto (6), *Paratrichogramma* Girault (7), *Poropoea* Förster (8), [*Prochaetostricha* K. Lin], [*Pseudogramminina* Ghesquière], *Pterandrophysalis* Nowicky (9), [*Pseudomirufens* Lou], *Soikiella* Nowicki (10), *Thanatogramma* n. gen. (11), *Trichogramma* Westwood (12), *Trichogrammatella* Girault (13), *Trichogrammatoidea* Girault (14), *Trichogrammatomyia* Girault (15), [*Urogramma* Girault], *Viggianiella* n. gen.\* (16), *Xenufens* Girault (17), [*Xenufensia* Girault], [*Zelogramma* Noyes and Valentine].

Oligositinae. **Paracentrobiini:** *Ittys* Girault (18), *Ittysella* Pinto and Viggiani (19), *Paracentrobia* Howard (20), [*Paraittys* Viggiani]. **Chaetostrichini.** *Adelogramma* n. gen. (21), *Adryas* Pinto and Owen (22), *Aphelinoidea* Girault (23), *Bloodiella* Nowicky (24), *Brachista* Walker (25), *Brachygrammatella* Girault (26), *Burksiella* De

Santis (27), *Centrobiopsis* Girault (28), *Chaetogramma* Doutt (29), *Chaetostricha* Walker (30), [*Densufens* N. Lin], *Lathromeris* Förster (31), [*Kyruwia* Pinto and George], *Lathromeroidea* Girault (32), [*Lathromeromyia* Girault], *Monorthochaeta* Blood (33), *Nicolavespa* Pinto (34), [*Paruscanoidea* Girault], *Pintoa* Viggiani (35), [*Pseudobrachysticha* Girault]\*, *Pseuduscana* n. gen. (36), *Pteranomalogramma* Viggiani and Velasquez\* (37), *Pterygogramma* Perkins (38), [*Thoreauia* Girault]\*, *Tumidiclava* Girault (39), *Tumidifemur* Girault (40), *Ufens* Girault (41), [*Ufensia* Girault], *Uscana* Girault (42), *Uscanella* Girault\* (43), *Uscanoidea* Girault (44), *Uscanopsis* Girault (45), *Xiphogramma* Nowicki (46), *Zaga* Girault (47), *Zagella* Girault (48). **Oligositini.** *Oligositina:* *Epoligosita* Girault (49), *Megaphragma* Timberlake (50), *Oligosita* Walker (51), *Prestwichia* Lubbock (52), [*Prosoligosita* Hayat and Hussein], *Sinepalpigramma* Viggiani and Pinto\* (53). **Eteroligositina:** [*Chaetostrichella* Girault], *Doiranina* Waterson (54), [*Eteroligosita* Viggiani], [*Hayatia* Viggiani], [*Probrachista* Viggiani]\*, *Pseudoligosita* Girault (55).

Genus unplaced to subfamily. [*Neolathromera* Ishii]\*

KEY TO THE NEW WORLD GENERA OF TRICHOGRAMMATIDAE  
(Numbers preceeding genera in key refer to order of presentation in text)

- 1. Scutellum with at least 2 pair of setae (anterior pair may be very short), midlobe of mesoscutum usually with 2 or more pair of setae (Figs 95, 179, 180, 184, 185). Eyes light to dark red in color. . . . . 2
- 1'. Scutellum and midlobe of mesoscutum each with 1 pair of setae (Figs 186, 187). Eyes black. (Oligositini). . . . . 60
- 2(1). Fore wing very narrow, 5–10× as long as wide (Figs 114a, b). Antenna with 2 funicular segments, both longer than wide; female club with two large spatulate sensilla (Fig. 15). . . . . 4. *Hydrophylita*
- 2'. Fore wing broader, considerably less than 5× as long as wide. Antenna with funicle variable in structure or entirely absent; female club without large spatulate sensilla. 3
- 3(2'). Antenna with 1 funicular segment (segment may be partially divided near middle as in Fig. 49). . . . . 4
- 3'. Antenna either with funicle absent or consisting of 2 segments (F1 often small and closely appressed to base of F2 as in Fig. 5). . . . . 8
- 4(3). Antennal club 1 segmented. . . . . 5
- 4'. Antennal club 2–3 segmented. . . . . 6
- 5(4). Fore wing densely setose (Fig.126); marginal vein (MV) contacting anterior margin of wing. Funicular segment partially divided (Figs 48, 49). Mesophragma notched apically (Fig. 193). Petiolar segment (immediately behind propodeum) without a transverse row of denticles. . . . . 29. *Chaetogramma* (in part)



- 5'. Fore wing sparsely setose (Fig. 110); MV not attaining anterior margin of wing. Funicular segment strongly constricted apically (Fig. 28) but not partially divided into 2 segments. Mesophragma entire apically (Fig. 194). Petiolar segment with a transverse row of denticles (Figs 188, 189). . . . . 7. *Paratrachogramma* ♀
- 6(4'). Fore wing narrow, 2.5–3.5× as long as wide with elongate fringe setae at least half fore wing width (FWW) (Fig. 129). Funicle with a strongly curved J-shaped placoid sensillum (PLS) (Fig. 52B). Midlobe of mesoscutum with 1 or 2 pair of setae; scutellum with anterior pair of setae much shorter than posterior pair (Figs 184–185). . . . . 35. *Pintoa*
- 6'. Fore wing wider, c. 1.5× as long as wide, with fringe setae short, much less than half FWW (Figs 111, 148). Funicle with PLS not strongly curved (Fig. 30). Both midlobe of mesoscutum and scutellum each with two pair of elongate setae (Fig. 180). . . . . 7
- 7(6'). Fore wing without an RS1 setal track (Fig. 111). Petiolar segment with a transverse row of denticles (Figs 188, 189). . . . . 10. *Soikiella* ♀
- 7'. Fore wing with a well developed RS1 setal track (Fig. 148). Petiolar segment without a transverse row of denticles. . . . . 24. *Bloodiella*
- 8(3'). Hind tibial spur extremely long and truncate apically, c. 0.9× the length of entire hind tarsus. . . . . 45. *Uscanopsis*
- 8'. Hind tibial spur considerably shorter, pointed apically, at most slightly longer than first tarsomere. . . . . 9
- 9(8'). Antenna with only 1 elongate postanellar segment (Fig. 35). . . . . 12. *Trichogramma* (*Trichogramma*) ♂
- 9'. Antenna with more than 1 postanellar segment. . . . . 10
- 10(9'). Fore wing venation strongly sinuate with greatest curvature basally, between premarginal and marginal veins; posterior margin of wing with a distinct preretinar lobe (Fig. 103). Male scape enormously inflated, its width greater than the length of club (Fig. 19); female scape unmodified (Fig. 18). . . . . 6. *Pachamaia*
- 10'. Fore wing venation not as above, either not sinuate at all, or if so, then apical curvature similar to or greater than basal curvature (Figs 104, 113); posterior margin of wing without a preretinar lobe. Male scape at most slightly inflated, its width never approaching length of club. . . . . 11
- 11(10'). Antenna with a 2-segmented funicle and a 1-segmented club. . . . . 12
- 11'. Antenna with funicle present or not but club at least 2 segmented. . . . . 19
- 12(11). Fore wing with abbreviated venation, stigmal vein (SV) reduced to a small appendix at apex of marginal vein (MV) (Fig. 110). Antenna with second funicular segment (F2) noticeably narrowed at apex, bottle shaped (Fig. 29). . . . . 7. *Paratrachogramma* ♂
- 12'. Fore wing venation not so abbreviated, SV variable but clearly diverging from MV, never reduced to a small appendix. Antenna with F2 not narrowed at apex, not bottle shaped. . . . . 13
- 13(12'). Fore wing (Fig. 116) with stigmal vein (SV) more than half the length of marginal vein (MV), positioned parallel to anterior wing margin, reaching 0.8 the wing length (FWL); fore wing disk virtually glabrous. Hind wing disk also glabrous, with anterior fringe very long, almost as long as posterior fringe (Fig. 98). . . . . 16. *Viggianiella* ♀ (♂ unknown)
- 13'. Fore wing with SV variable in length but distinctly divergent from anterior wing margin, not reaching beyond 0.6 FWL; fore wing disk noticeably setose. Hind wing disk with one or more setal tracks, its anterior fringe considerably shorter than posterior fringe. . . . . 14

14(13'). Fore wing venation sinuate, with marginal vein (MV) gradually curving away from anterior wing margin onto stigmal vein (SV) (Figs 113, 114). Mesophragma entire apically (Fig. 194). . . . . 15

14'. Fore wing venation not sinuate; MV ending abruptly distally, not gradually curving onto SV (Fig. 115). Mesophragma notched apically (Fig. 193). . . . . 16

15(14). Fore wing with RS1 track present behind stigmal vein (SV) (Figs 113, 158); premarginal vein (PM) with 2 setae. Hind wing usually with at least 2 setal tracks (a complete middle track and a complete or partial posterior track). . . . . 12. *Trichogramma* ♀

15'. Fore wing without an RS1 track behind SV (Fig. 114); PM with 1 seta. Hind wing with only a middle setal track which is not complete to wing apex. . . . . 14. *Trichogrammatoidea* ♀

16(14'). Fore wing (Fig. 115) fringe setae elongate, their maximum length at least half wing width (FWW); venation evenly sclerotized; fore wing disk only moderately densely setose, setae arranged in linear tracks which continue to apex of wing. Antennal club unevenly tapering to apex (Fig. 37). . . . . 15. *Trichogrammatomyia* ♀ (in part)

16'. Fore wing (Figs 125, 126) fringe setae short, their maximum length no more than 0.2× FWW; venation unevenly sclerotized, base of marginal vein and apex of premarginal vein much lighter in coloration; fore wing disk densely setose, setae scattered, linear setal tracks poorly indicated especially in apical fourth of wing. Antennal club evenly tapering to apex (Fig. 48). . . . . 17

17(16'). Ovipositor elongate, extending entire length of metasoma and well beyond its apex (Fig. 195). Funicle with 2 completely divided segments (Fig. 62). Male without aedeagal apodemes (AAP) (Fig. 239). . . . . 46. *Xiphogramma*

17'. Ovipositor shorter, not extending entire length of metasoma, nor appreciably beyond its apex. Funicle either distinctly 2 segmented or only partially divided. Male with AAP (Fig. 229). . . . . 18

18(17'). Fore wing with marginal vein (MV) densely setose (Fig. 125); funicle distinctly two segmented. . . . . 26. *Brachygrammatella* (in part)

18'. Fore wing with MV not densely setose (Fig. 126); funicle only partially divided (Fig. 49). . . . . 29. *Chaetogramma* (in part)

19(11'). Maxillary palp 2 segmented (Fig. 173). . . . . 20

19'. Maxillary palp 1 segmented (Fig. 172). . . . . 27

20(19). Antenna with a distinct 2-segmented funicle. . . . . 21

20'. Antenna without a funicle. . . . . 25

21(20). Fore wing with marginal vein (MV) extremely short and broad, subquadrate, much shorter and wider than premarginal vein (PM) (Fig. 108). . . . . 1. *Brachyufens* (in part)

21'. Fore wing with MV not subquadrate, distinctly longer than wide, its length relative to that of PM variable, but never much wider. . . . . 22

22(21'). Pedicel of antenna with transverse, crenulate ridges (Fig. 16); male club with a small fourth segment (Fig. 17). Fore tibia with several thorn-like spines on dorsal surface (Fig. 178). . . . . 5. *Mirufens*

22'. Pedicel of antenna relatively smooth, without transverse, crenulate ridges; male club usually 3, less commonly 4 segmented. Fore tibia lacking thorn-like spines on dorsal surface (Fig. 175). . . . . 23

- 23(22'). Fore wing venation distinctly sinuate; stigmal vein (SV) perpendicular to marginal vein (MV) (Fig. 104). . . . . 8. *Poropoea*
- 23'. Fore wing venation not sinuate; SV slanted diagonally away from MV. . . . . 24
- 24(23'). Antenna with 2 anelli; first funicular segment (F1) strongly transverse (Figs 22, 23); male antennal club 3 segmented. Male fore wing venation enormously inflated, occupying almost entire basal width of wing (Fig. 106). Male genitalia without an intervalsellar process (IVP) (Fig. 207). . . . . 9. *Pterandrophysalis*
- 24'. Antenna with 3 anelli (Fig. 1); F1 usually longer than wide or subquadrate, rarely somewhat transverse; male antennal club 3 or 4 segmented. Male fore wing venation not inflated (Figs 99, 100). Male genitalia with an elongate IVP (Figs. 201, 202). . . . . 2. *Ceratogramma*
- 25(20'). Fore wing venation sinuate, its greatest curvature apically where marginal vein (MV) gradually curves away from anterior wing margin onto an elongate, slender stigmal vein (SV) (Fig. 107). Petiolar segment without a transverse row of denticles. . . . . 13. *Trichogrammatella*
- 25'. Fore wing venation not sinuate; MV ending abruptly distally, not gradually curving onto SV (Figs 108, 109). Petiolar segment with a transverse row of denticles (Figs 188, 189). . . . . 26
- 26(25'). Midlobe of mesoscutum with 3 pair of elongate setae (Fig. 179). Fore wing with marginal vein (MV) short, subquadrate, distinctly shorter and c. 3× wider than premarginal vein (PM) (Fig. 108). . . . . 1. *Brachynifens* (in part)
- 26'. Midlobe of mesoscutum with 2 pair of elongate setae (Fig. 180). Fore wing with MV not subquadrate, its width considerably less than 3× that of PM (Fig. 109). . . . . 3. *Haeckeliania*
- 27(19'). Antenna with funicle present. . . . . 28
- 27'. Antenna with funicle absent. . . . . 44
- 28(27). Fore wing venation sinuate, greatest curvature distally where marginal vein (MV) gradually curves away from anterior wing margin onto stigmal vein (SV) (Figs 113, 114, 117). . . . . 29
- 28'. Fore wing venation not sinuate, MV ending abruptly distally, not gradually curving onto SV (as in Figs 128, 135, 149). . . . . 31
- 29(28). Antennal club distinctly 3 segmented; funicular segments subquadrate or only slightly transverse (Fig. 36). Fore wing with marginal vein (MV) attaining anterior margin of wing. . . . . 30
- 29'. Antennal club with only 2 complete segments, a third (if present) incompletely separated from second; funicular segments strongly transverse (Figs 40–42). Fore wing with MV placed slightly behind anterior margin of wing. . . . . 17. *Xenifens*
- 30(29). Fore wing with RS1 present (Fig. 113); premarginal vein (PM) with 2 setae. Male genitalia with a dorsal lamina (DLA) (Figs. 198, 218). . . . . 12. *Trichogramma* (*Vanlisus*) ♂
- 30'. Fore wing without an RS1 (Fig. 114); MV with only 1 seta. Male genitalia without a DLA (Fig. 220). . . . . 14. *Trichogrammatoidea* ♂
- 31(28'). Antenna with the first funicular segment (F1) distinctly shorter and narrower than the second (F2) and closely appressed to F2 (Figs 51, 71, 84, 267, 268). . . . . 32
- 31'. Antenna with F1 as wide as F2 and usually subequal to or longer than F2 (Figs 31–33, 43–45, 59, 60), if shorter (Fig. 38) then dorsum of petiolar segment with a transverse row of denticles (Figs 188, 189). . . . . 36



32(31).	Female antennal club with a terminal process (Fig. 51). Male genitalia with apodemes (AAP) of aedeagus and volsellae (VS) present (Figs 232, 233). North and Central America. ....	34. <i>Nicolavespa</i>
32'.	Female antennal club without a terminal process. Male genitalia with AAP and VS usually absent, if present then occurring in South America. ....	33
33(32').	Fore wing unique, almond shaped, apical margin pointed; disk without setae behind venation; RS1 absent; fringe setae elongate, their length at least half the fore wing width (FWW). ....	37. <i>Pteranomalogramma</i> (♂ unknown)
33'.	Fore wing not almond shaped, apical margin broadly rounded; disk with setation behind venation; RS1 present; fringe setae shorter, their length never approaching half FWW. ....	34 <sup>1</sup>
34(33').	Fore wing venation (Fig. 150) without a constriction between stigma and marginal vein (MV); stigma not extending apicad to apex of MV (a line drawn through stigmal vein to wing margin describes a right angle with MV); RS1 usually of 5 or fewer setae, arranged in a straight line, directed toward posterior margin of wing, subperpendicular to Cu tracks. Male genitalia with ventral setae (Fig. 255). ...	48. <i>Zagella</i>
34'.	Fore wing venation (Figs 142, 143) with a constriction between stigma and MV; stigma extending apicad to apex of MV (a line drawn through stigma to wing margin describes an oblique angle with MV); RS1 longer, consisting of more than 5 setae, distinctly curved or arranged in a straight line but directed toward base of wing and usually converging with Cu tracks. Male genitalia almost always without ventral setae (Figs 243, 245). ....	35
35(34').	Antenna with funicle narrower than club (Fig. 72A). Fore wing with RS1 relatively straight (Fig. 143). Foretibia with a prominent thorn-like spine at middle of dorsal surface (Fig. 176). Ovipositor usually extending beyond apex of metasoma. Male genitalia narrow and elongate, almost always as long or longer than hind tibia (Figs 244, 245). North America. ....	30. <i>Chaetostricha</i>
35'.	Antenna with funicle slightly wider than club (Fig. 69). Fore wing with RS1 broadly curved (Fig. 142). Fore tibia without a thorn-like spine at middle of dorsal surface. Ovipositor shorter, not extending beyond apex of metasoma. Male genitalia short, broader (Figs 242, 243), considerably shorter than hind tibia. Broadly distributed. ....	27. <i>Burksiella</i>
36(31').	Fore wing with long fringe setae, their maximum length at least half width of wing (FWW) (Fig. 115). Antenna with funicular segments distinct, F1 shorter or equal in length to F2 (Figs 37, 38). ....	15. <i>Trichogrammatomyia</i> ♀ (in part), ♂
36'.	Fore wing usually with fringe setae distinctly shorter than half FWW but if longer then funicle with F2 noticeably shorter than F1. ....	37
37(36').	Antenna with both funicular segments, and first 2 club segments (C1, C2) each with several thick, spiniform placoid sensilla (PLS) attached to antennal surface only at base (Fig. 31). ....	10. <i>Soikiella</i> ♂
37'.	Antenna without thick spiniform PLS; funicle either without PLS entirely (Figs 32, 33, 43–45) or with all but apex of PLS attached to surface (Figs 59, 60). ....	38
38(37').	Antenna with funicular segments each with at least 1 placoid sensillum (PLS); funicle broad, subequal in width to base of club. ....	39

<sup>1</sup>An apparent new genus, very recently collected from several localities in central Chile, keys to this point (RS1 absent, however) but fits neither part of couplet 34. Only females are known. Its antenna is typical of certain members of the *Chaetostricha* group such as *Chaetostricha* and *Zagella* (2-segmented funicle, F1 very short and appressed to F2, club 3 segmented) but the fore wing is unique. The apparent absence of a stigmal vein and the lack of the RS1 track separate it from other genera with similar antennal structure. Actually a stigmal vein is present in this taxon but it lacks all pigmentation.

- 38'. Antenna with funicular segments lacking PLS; funicle distinctly narrower than base of club (Figs 32, 33, 43–45). . . . . 41
- 39(38). Fore wing (Fig. 135) moderately densely setose with distinct linear setal tracks throughout, including a well defined RS1. Male antennal club 4 segmented (Fig. 60). . . . . 41. *Ufens*
- 39'. Fore wing densely setose, without well defined linear setal tracks, RS1 absent. Male antennal club with fewer than 4 segments. . . . . 40
- 40(39'). Fore wing with marginal vein (MV) densely setose, with more than 10 setae dorsally (Fig. 125); stigmal vein (SV) indistinct, short, without a constriction between stigma and MV. . . . . 26. *Brachygrammatella* (in part)
- 40'. Fore wing with MV normally setose, with fewer than 10 setae dorsally; SV distinct, with a constriction between stigma and MV. . . . . 33. *Monorthochaeta*
- 41(38'). Petiolar segment with a transverse row of denticles dorsally (Figs 188, 189). Fore wing (Fig. 112) without an RS1; fringe setae short, c. 0.1 wing width (FWW). Female antennal club (Fig. 32) 2 segmented, apical segment (C2) with a patch of recurved setae (RS) ventroapically; male antennal club 3 segmented. Male genitalia with aedeagus (ADG) distinct from genital capsule (GC) and much longer than capsule (Figs 215–217). . . . . 11. *Thanatogramma*
- 41'. Petiolar segment without a transverse row of denticles dorsally. Fore wing with or without an RS1; fringe setae variable but length greater than 0.1 FWW. Antennal segment number similar in both sexes. Female club without a patch of RS ventroapically on apical segment. Male genitalia with ADG incorporated into GC (Figs 224–226). . . . . 42
- 42(41'). Antennal club 2 or incompletely 3 segmented; only 1 anellar segment present (Fig. 45). Fore wing with RS1 absent (Fig. 120). . . . . 19. *Ittysella*
- 42'. Antennal club distinctly 3 segmented; 2 anelli present (Figs 43, 44). Fore wing with RS1 present or absent (Figs 118, 119). . . . . 43
- 43(42'). Funicular segments relatively elongate (Fig. 44), the first (F1) longer than wide, second (F2) about as long as wide. Fore wing with RS1 present (Fig. 119). Male with sternum VIII modified into two broad plate-like appendages (Fig. 225). . . . 18. *Ittys*
- 43'. Funicular segments shorter (Fig. 43), F1 about as wide as long, F2 transverse, distinctly broader than long. Fore wing usually without a distinct RS1 (Fig. 118). Male sternum VIII modified into two narrow, strap-like appendages (Fig. 224). . . . . 20. *Paracentrobia*
- 44(27'). Head with a unique deep and relatively large pit immediately in front of anterior ocellus (Figs 165–167). Metasomal tergum II (first visible) with an oval, clear bulla anterolaterally (Fig. 196). . . . . 32. *Lathromeroidea* (in part)
- 44'. Head without a deep pit in front of anterior ocellus. Metasomal tergum II (first visible) lacking anterolateral bullae. . . . . 45
- 45(44'). Fore wing with stigmal vein (SV) short, sessile, not distinct from marginal vein (MV); disk densely setose, RS1 not indicated. Figs 121–123, 159. . . . . 46
- 45'. Fore wing with a relatively elongate SV which is distinct from MV; disk not densely setose, RS1 usually present. As in Figs 140, 144, 149. . . . . 47
- 46(45). Female antennal club with a distinct terminal process at apex (Fig. 56). Male metasomal tergum VII (and often VI as well) with a pair of lateral suboval or reniform pustules (as in Fig. 264). Fore wing with setal tracks R and RS2 distinct and well separated (Fig. 132). Hind wing with only 2 complete setal tracks, the third (posterior) track absent at least in basal half. . . . . 39. *Tumidiclava*

46'.	Female antennal club without a terminal process at apex (Fig. 46). Male metasomal terga without pustules. Fore wing disk more uniformly and densely setose, without distinct R and RS2 setal tracks (Figs 121–123). Hind wing with at least 3 complete setal tracks. ....	23. <i>Aphelinoidea</i>
47(45').	Antennal club with first segment (C1) very short, transverse, usually closely appressed to base of second (C2), without placoid sensilla (PLS), its width not approaching maximum club width (Figs 6, 65, 66, 73, 74, 76–83). ....	48
47'.	Antennal club with C1 longer, variable in shape but its width subequal to maximum club width, often bearing PLS (Figs 58, 61). ....	54
48(47).	Fore wing of female (Fig. 140) with premarginal (PM) and marginal veins (MV) confluent; PM subtriangular, widest basally, distinctly wider than MV and with a distinct gap between subcostal (SC) and PM veins. Fore wing of male similar or, in some species, with PM and base of MV inflated and subequal in width (Fig. 141). ....	22. <i>Adryas</i>
48'.	Fore wing not as above. PM not subtriangular in shape, narrower than or subequal in width to MV; PM and MV confluent or not. Fore wing of male never with inflated venation. ....	49
49(48').	Fore wing with RS1 absent; disk sparsely setose overall, subglabrous between r-m and Cu2; fringe setae elongate, length c. half width of wing (FWW). ....	43. <i>Uscanella</i> ♀ (♂ unknown)
49'.	Fore wing with RS1 present; disk moderately densely setose throughout; fringe setae varying in length but usually considerably less than half FWW. ....	50
50(49').	Fore wing venation (Figs 149, 162) without a constriction between stigma and marginal vein (MV); stigma not extending apicad to apex of MV (a line drawn through stigmal vein to wing margin describes a right angle with MV). Foretibia usually with a prominent thorn-like spine at middle of dorsal surface (Fig. 177). ....	47. <i>Zaga</i>
50'.	Fore wing venation (Figs 143, 144, 147, 161) with a constriction between stigma and MV; stigma extending apicad of apex of MV (a line drawn through stigmal vein to wing margin describes an oblique angle with MV) (rarely without a well defined stigmal vein). Fore tibia variable, rarely spinose but if so without a more prominent spine at middle of dorsal surface (Figs 175, 178). ....	51
51(50').	Female antennal club obsolescently segmented (Figs 63, 64, 66), only 3 complete segments present: a minute C1, a short transverse C2, and an elongate and only partially divided C3/4/5; with at least 1 placoid sensillum (PLS) spiniform (free of surface entire length) and with PLS on C2 extending beyond surface for at least half its length. Male antenna unique (Fig. 65), club distinctly 5 segmented, C3, C4 and C5 each with 1 or more long spiniform PLS which exceed the length of the club itself. ....	21. <i>Adelogramma</i>
51'.	Male and female antennal club both 5 segmented (Figs. 73–78); PLS not spiniform, not extending far beyond antennal surface. ....	52
52(51').	Ovipositor elongate, extending entire length of metasoma with c. ¼ of its length extending beyond metasomal apex. Male genitalia elongate, narrow, longer than hind tibia (HTL), with a longitudinal furrow ventrally (Fig. 251). . .	28. <i>Centrobiopsis</i>
52'.	Ovipositor shorter, not extending appreciably beyond apex of metasoma. Male genitalia considerably shorter with length less than HTL and without a longitudinal furrow ventrally (Figs 249, 250). ....	53
53(52').	Propodeal disk and metanotum usually subequal in length (Fig. 182). Fore wing relatively broad (usually < 2× as long as wide) with short fringe setae (usually < 0.2 wing width) and a broadly curved RS1 (Fig. 147). Male genitalia usually without ventral setae (Fig. 250). ....	44. <i>Uscanoida</i>



- 53'. Propodeal disk longer than metanotum (Fig. 181). Fore wing narrower ( $\geq 2\times$  as long as wide) with longer fringe setae ( $\geq 0.2$  wing width); RS1, if obvious, usually relatively straight, not broadly curved (Figs 144–146). Male genitalia usually with ventral setae (Fig. 249). . . . . 32. *Lathromeroidea* (in major part)
- 54(47'). Antennal club 2–4 segmented. . . . . 55
- 54'. Antennal club 5 segmented. . . . . 58
- 55(54). Fore wing disk moderately to densely setose, without distinct setal lines at least in posterior two-thirds; RS1 usually absent (Figs 124, 133, 134). . . . . 56
- 55'. Fore wing disk moderately densely setose, with distinct setal lines including RS1 (Figs 130, 136). . . . . 57
- 56(55). Fore wing with several short stiff setae in costal cell and on marginal vein (MV); stigmal vein (SV) diverging only slightly from MV (Figs 133, 134, 160). Female without strut-like apodemes extending anteriorly from near base of ovipositor. . . . . 40. *Tumidifemur*
- 56'. Fore wing without numerous setae in costal cell and on MV; SV strongly divergent from MV (Fig. 124). Female with a pair of strut-like apodemes extending anteriorly from near base of ovipositor (Fig. 265). . . . . 25. *Brachista*
- 57(55'). Antennal club with first segment (C1) as long or longer than second (C2); female with 1 or more placoid sensilla (PLS) on C1 (Fig. 61). Uniformly brown in color. Male genitalia simple, without volsellae (VS) or parameres (PAR) (as in Fig. 250). . . . . 42. *Uscana*
- 57'. Antennal club with C1 distinctly shorter than C2, C1 without placoid sensilla in both sexes (Figs 53, 54). Distinctly bicolored, brown with white coloration on much of mesosoma and legs. Male genitalia variable, most species with distinct VS and PAR (as in Fig. 235). . . . . 36. *Pseuduscana*
- 58(54'). Female antennal club with a terminal process at apex (Fig. 50). Fore wing with RS1 absent, discal setation moderately dense at most (Fig. 127). Male metasomal tergum VI (and often VII) with modified areas as indicated in Figs 262–264. . . . . 31. *Lathromeris*
- 58'. Female antennal club without a terminal process at apex. Fore wing with an RS1 (Figs 131, 144, 145), if RS1 not obvious then disc densely setose, obscuring most linear setal tracks (Fig. 146). Male metasomal terga without modified areas. . . . . 59
- 59 (58'). Antennal club with first segment (C1) longer than second (C2); C2 transverse, shortest segment of club; C1 with a placoid sensillum (PLS) (Figs 55, 94). Hind wing disk usually with only 1 setal track. Male genitalia with aedeagal apodemes (AAP) (Fig. 96). . . . . 38. *Pterygogramma*
- 59'. Antennal club with C1 distinctly shorter than C2; C1 shortest segment of club and without a PLS (Figs 73–77). Hind wing disk with at least 2 linear setal tracks. Male genitalia without AAP (Figs 246, 248). . . . . 32. *Lathromeroidea* (in part)
- 60(1'). Maxillary palp entirely absent (Fig. 171). Antenna without placoid sensilla (PLS) on surface. Mesosomal dorsum exceedingly smooth, without reticulae. . . . . 53. *Sinepalpigramma*
- 60'. Maxillary palp present (Fig. 172). Antenna with PLS on surface of club. Mesosomal dorsum sculptured, at least with obsolescent reticulae. . . . . 61
- 61(60'). Fore wings very narrow, c.  $7\times$  as long as wide (Figs 152, 154). . . . . 62
- 61'. Fore wings broader, no more than  $4\times$  as long as wide (Figs 151, 153, 156, 157). . . . . 63
- 62(61). Antenna with 3 postanellar segments (Fig. 87). Fore wing sparsely setose with only 1 or 2 rows of setae on disk at most (Fig. 152). . . . . 50. *Megaphragma*

62'. Antenna with 4 postanellar segments (Fig. 90). Fore wing densely setose (Fig. 154). . . . . 52. *Prestwichia*

63(61'). Metasomal terga uniformly sclerotized their entire length. Propodeal disk usually distinctly longer than metanotum at midline (Fig. 186). Mesopleuron with pleural suture (Fig. 192). . . . . 64

63'. Metasoma with at least the 3 anterior terga longitudinally striate posteriorly, uniformly sclerotized anteriorly (Figs 187, 197). Propodeal disk only slightly longer than metanotum (Fig. 187). Mesopleuron without a pleural suture (as in Figs 191, 197). . . . . 65

64(63). Fore wing disk entirely glabrous (with at most 1 or 2 setae) (Fig. 151). Antennal club 1 or incompletely 2 segmented. Mesosoma with a small subtriangular lobe arising beneath propodeal disk. Mesotarsus elongate, distinctly longer than mesotibia. . . . . 49. *Epiligosita*

64'. Fore wing disk sparsely to moderately densely setose (Fig. 153). Antennal club 3 segmented. Mesosoma without a subtriangular lobe beneath propodeal disk. Mesotarsus not longer than mesotibia. . . . . 51. *Oligosita*

65(63'). Antennal club 1 segmented (Fig. 92). Male genitalia simple, only slightly curved ventrally, without posteriorly directed apodemes at base (as in Fig. 258). . . . . 54. *Doirania*

65'. Antennal club 3 segmented (Fig. 93). Male genitalia strongly curved ventrally, with posteriorly directed apodemes at base (Fig. 259). . . . . 55. *Pseudoligosita*

GENERIC REVIEWS ARRANGED BY  
SUBFAMILY AND TRIBE

Trichogrammatinae

*Diagnosis.*—Maxillary palp 1 or 2 segmented. *Male.* Type 1 genitalia. GC and ADG distinct, ADG capable of movement independently of GC and discernible from GC its entire length; GC with VS and PAR (apparently united into a single lobe in *Xenufens*). Figs 198–223.

*Discussion.*—The Trichogrammatinae consists of the nominate tribe only. Its definition differs from that of Viggiani (1971) by excluding genera having male genitalia in which the aedeagus and genital capsule are consolidated and indistinguishable apically but with aedeagal apodemes basally (Figs 224–230). Excluded from the subfamily on this basis are the Paracentrobiini as well as certain genera previously placed in the Trichogrammatini (*Aphelinoidea*, *Brachygrammatella*, *Lathromeris*, *Monorthochaeta*, *Tumidiclava*, *Ufens*). All are herein assigned to the Oligositinae, the latter six genera to the Chaetstrichini.

Trichogrammatini Westwood

*Discussion.*—Most genera of Trichogrammatini can be assigned to one of two phenetic groups. In one (Group 1) the antenna has five postanellar segments in both sexes, the maxillary palp usually is two segmented, axillae and axillulae are relatively well separated from the scutellum, and the male genital capsule is open its entire length dorsally and trough-like in appearance. These are generalized features. The male genitalia retain several of the basic features characterizing Hymenoptera (Snodgrass 1957), the antennae are minimally dimorphic sexually with seven to nine flagellomeres (the maximum number for the family), consolidation of the mesosomal tergites is minimal, and the maxillary palp remain unreduced (nominate subgenus of *Hydrophylita* an exception). New World genera with these characteristics include *Brachyufens*, *Cerato-gramma*, *Haeckeliana*, *Hydrophylita*, *Mirufens*, *Poropoea*, *Pterandrophysalis*, and

*Trichogrammatella*. Several extralimital genera such as *Ophioneurus* and *Oligositoides* also belong here. I am aware of no derived feature shared by these taxa and this basal assemblage is apparently paraphyletic. The majority of genera in this group with known hosts are parasitoids of Curculionioidea. Included are *Brachyufens*, *Ceratogramma*, *Haeckeliania*, *Ophioneurus*, *Poropoea*, and *Pterandrophysalis*. Coleoptera parasitization is not common in other segments of the family, suggesting that this association is primitive for the Trichogrammatidae. *Mirufens*, *Trichogrammatella* and the African genus *Oligositoides* parasitize eggs of auchenorrhynchos Hemiptera, hosts utilized by perhaps the majority of Oligositinae.

Genera in the second group of Trichogrammatini (Group 2) have more derived features. The antenna has fewer than five postanellar segments at least in the female, the maxillary palp usually is one segmented, axillae and axillulae are poorly delineated from the scutellum, and the first metasomal (petiolar) tergum usually has a transverse row of denticles. The male genital capsule is variable. It can be completely open dorsally and trough-like as in Group 1 or possess a transverse bridge dorsal to the aedeagus in the apical half of the capsule. New World genera in Group 2 include *Pachamama*, *Paratrichogramma*, *Soikiella*, *Thanatogramma*, *Trichogramma*, *Trichogrammatoidea*, *Trichogrammatomyia*, *Viggianiella* and *Xenufens*. The Australian genera *Australufens*, *Brachyia*, *Pseudogrammina*, and *Urogramma* also belong here. Based on male genitalia and female antennal structure (Noyes and Valentine 1989), the New Zealand genus *Zelogramma* is a possible member of this group as well.

*Paratrichogramma*, *Thanatogramma*, *Trichogramma*, *Trichogrammatoidea*, *Trichogrammatomyia* and *Xenufens*, as well as the four Australian genera mentioned share several derived features. In all, the petiolar tergum has a transverse row of denticles, and the female antenna is characterized by a sub-

oval club of one or two closely appressed segments with short funicular segments lacking placoid sensilla. Four of these genera (*Thanatogramma*, *Trichogramma*, *Trichogrammatoidea*, and *Xenufens*) have mandibles with a large socketed apical tooth, as far as I know the only occurrence of this structure in the family. Additionally, all taxa in this assemblage with known hosts (*Australufens*, *Paratrichogramma*, *Trichogramma*, *Trichogrammatoidea*, *Trichogrammatomyia*, *Xenufens*) parasitize eggs of Lepidoptera, an uncommon host group in other segments of the family.

The row of denticles on metasomal tergum I is a unique feature occurring only in the Trichogrammatini. There is not yet convincing evidence that this trait delimits a monophyletic group. It occurs in all Group 2 genera except *Viggianiella* and *Pachamama*. It also is present in Group 1 genera *Haeckeliania* and *Brachyufens*.

### 1. *Brachyufens* Viggiani (Figs 24, 25, 108, 179)

*Brachyufens* Viggiani, in Doutt and Viggiani 1968. Type species: *Ufens osborni* Dozier, by original designation.

*Diagnosis.*—*Female.* Antenna with 2 anelli and 5 club segments; however 3 basal-most postanellar segments relatively large, loosely associated and often not easily categorized as funicular or club segments; 2 terminal club segments closely appressed with apical-most segment subconical, with RS on ventral surface; postanellar segments with PLS extending considerably beyond surface but attached for at least half their length. Maxillary palp 2 segmented. Mid-lobe of mesoscutum with 3 pair of elongate setae. Propodeum narrowing to middle, anterior margin broadly V-shaped. Fore wing broad, oblate, less than 2× as long as wide, fringe setae short; venation unique:—MV very short, subquadrate, distinctly shorter and c. 3× wider than PM, SV and radial process well developed, costal cell large; disk moderately densely setose with



few linear setal tracks apparent, RS1 present. Metasomal tergum I (petiole) with a transverse row of denticles.

**Male.** Antenna with 5 relatively large, loosely articulated segments (5-segmented club), each segment with a whorl of spiniform PLS which are attached to surface only at base. Genitalia similar to *Haeckeliania*.

**Distribution.**—North America.

**Diversity.**—*Brachyufens osborni*, known from the West Indies and southeastern United States, is the only species described. Originally placed in *Ufens*, it was removed and treated as the type species of *Brachyufens* by Viggiani (in Doutt and Viggiani 1968). One or two undescribed species occur in Mexico and the southwestern United States.

**Discussion.**—*Brachyufens* is likely a derived element of *Haeckeliania*. General body shape, antennal structure in both sexes, the maxillary palpi, and male genitalia are similar in both. Although the large quadrate marginal vein separates *Brachyufens* from the vast majority of *Haeckeliania* (cf. Figs 108, 109), there are undescribed Australian species of the latter which approach *Brachyufens* in this regard. The number of setae on the mesoscutum also should separate the two genera as currently defined. Both genera are known to parasitize curculionid eggs.

*Brachyufens* females were characterized by their two-segmented funicle and three-segmented club in Doutt and Viggiani (1968). Because of the loose association of the first three postanellar segments the antenna is difficult to characterize especially on slide-prepared material. Specimens may appear as 2F/3C, 3F/2C or 5C depending on the preparation. The five postanellar segments in males (previously unknown) are all loosely associated and more clearly comprise a five-segmented club.

**Records.**—**Mexico:** Baja California Sur, Veracruz. **United States:** California, Florida, Texas. **West Indies.**

**Hosts.**—Coleoptera: Curculionidae (Schaff 1987).

## 2. *Ceratogramma* De Santis, renewed status

(Figs 1, 3, 12–14, 99, 100, 190, 200–202)

*Ceratogramma* De Santis 1957. Type species: *Ceratogramma schachovskoyi* De Santis, by original designation. Pinto and Viggiani 1991 (generic review). Fursov 1995a (as synonym of *Szelenyia* Nowicki).

**Diagnosis.**—**Female.** Antenna with 3 anelli, 2 funicular and 3 club segments; funicular segments distinctly separate from one another. Maxillary palp 2 segmented. Midlobe of mesoscutum and scutellum each with 2 (sometimes 3 in one species) pair of elongate setae. Fore wing 1.8–2.0× as long as wide; venation with MV diverging from wing margin at base, usually confluent with PM, PM (and base of MV) strongly divergent from wing margin, resulting in a large, often highly setose costal cell, a short postmarginal vein present or not, SV distinct, constricted between stigma and MV, slanted diagonally toward middle of apical margin of wing; disk densely setose, distinct setal tracks absent or few in number, RS1 absent.

**Male.** Antennal club 3–4 segmented. GC entirely open dorsally, with an elongate IVP which usually extends to or beyond apex of PAR and VS.

**Distribution.**—Southwestern United States, Florida (introduced), West Indies, Central and South America in the New World; Europe.

**Diversity.**—Nine species are assigned to *Ceratogramma*. Eight occur in the New World. This includes *C. jeffersi*, a new species described below, the only indigenous *Ceratogramma* from the United States. The only other species known from the USA, *Ceratogramma etiennei* Delvare, was recently introduced into Florida from the West Indies for control of the root weevil, *Diaprepes abbreviatus* (L.) (Hall et al. 2001). The remaining six New World *Ceratogramma* include *C. brasiliense* Viggiani, *C. magnificum* Pinto and Viggiani, *C. masneri*

Pinto and Viggiani, *C. robustum* Pinto and *C. schachovskoyi*.

**Discussion.**—*Ceratogramma* is most similar to *Pterandrophysalis* and *Mirufens*. It is separated from these and all other New World genera by the three anellar segments. The postanellar antennal formula (funicle of two distinct segments, club of three or four segments), fore wing venation and setation, non-spinose fore tibia, and the elongate intervolsellar process in males also help separate this genus. An intervolsellar process is absent in *Pterandrophysalis* and *Mirufens*.

*Ceratogramma* was treated as a junior synonym of the Old World *Szelenyia* by Fursov (1995a). It is resurrected here and includes eight New World species, and the recently described Spanish species, *Ceratogramma tatianae* (Fursov), **new combination**. The generic synonymy proposed by Fursov was prompted by the discovery of *tatianae*. The fact that certain features also are shared with *Szelenyia tamaricis* Nowicki prompted synonymy. Included are similar fore wing venation and setation, similar antennal segmentation, and the two-segmented maxillary palp.

As indicated by Pinto and Viggiani (1991) *Ceratogramma* is indeed similar to *Szelenyia*. Synonymy may eventually be appropriate, but at the present time I am unable to identify clearly derived features shared by *S. tamaricis* and *Ceratogramma* species, nor did Fursov (1995a) propose any. Whereas *Ceratogramma*, as defined here, is convincingly monophyletic, the concept of *Szelenyia* offered by Fursov renders the genus difficult to define except by a combination of generalized and likely primitive features. Thus, the two defining traits of *Ceratogramma*, the three anellar segments and a prolonged intervolsellar process (male unknown in *C. tatianae*, however), are unique synapomorphies not shared by *S. tamaricis*. Features used to argue a tie to *S. tamaricis*, also are characteristic of other primitive trichogrammatid genera. The limited material of *Szelenyia*

available for this study suggests that there are undescribed species in Europe and Africa similar to *S. tamaricis*. Also, as indicated below, *Szelenyia* is considerably more similar to *Pterandrophysalis* than to *Ceratogramma*. Pending a study of this entire generic complex it seems more practical to retain original definitions which at least allow the unambiguous identification of both *Szelenyia* and *Ceratogramma* (see Doutt and Viggiani 1968, Pinto and Viggiani 1991).

**New World records.**—**Argentina:** Neuquén. **Brazil:** Santa Catarina. **Chile:** Regions VIII, IX, X. **Colombia.** **Costa Rica.** **Ecuador.** **French Guiana.** **Guatemala.** **Panama.** **Peru.** **United States:** Florida (introduced), New Mexico, Texas, Utah. **Venezuela.** **West Indies.**

**Hosts.**—Coleoptera: Curculionidae (Delvare 1988).

***Ceratogramma jeffersi* Pinto, new species**  
(Figs 13, 14, 100, 202)

**Diagnosis.**—Antennal shape and segment number similar in both sexes; scape not inflated. Fore wing without fumation; MV shorter than both SV and PM; postmarginal vein, radial process and basal vein track absent. Mesophragma entire apically, not notched.

**Description.**—Body length c. 1.0 mm. Color uniformly dark brown except tarsi, base and apex of tibiae and antennal flagellum considerably lighter, also with a slightly lighter midline on mesoscutum and scutellum. Fore wing disk clear, without fumation. **Female.** Head about a third wider than long, slightly wider than mesosoma. Toruli placed at middle of upper face. Mandible with 2 strong posterior teeth, ental surface crenulate anteriorly. Maxillary palpal segments elongate, cylindrical, 0.7× length of mandible, segment II c. 1.5× length of I; terminal seta on II slightly longer than length of segment. Measurements (length/width; holotype) of antennal scape, pedicel, F1, F2 and club as

follows: 64/23, 35/27, 31/33, 35/30, 95/35; club symmetrical, widest near junction of C1 and C2 then tapering evenly to apex, C1 c.  $0.7\times$  the length of C2, C2 slightly shorter than C3, C3 subconical and without a patch of RS apicoventrally; PLS on all postanellar segments; F2 and club segments each with a single whorl of FS; F1 with one elongate APB and a few short APA; BPS at apex of funicular and club segments very small, narrow, only slightly expanded apically; longest FS c.  $1.4\times$  maximum club width; scape not inflated. Midlobe of mesoscutum usually with 3 pair of elongate, stout setae (only 2 pair in female from New Mexico, and 4 setae on left side of holotype); scutellum with 2 pair of similar setae. Scutellum relatively long, c.  $0.7\times$  length of mesoscutum. Sculpturing on mesoscutum and scutellum primarily lineate with very elongate, narrow cells, cells wider laterally and basally on both structures. Mesophragma entire, not notched apically. Fore wing  $1.6\times$  as long as wide, venation attaining  $0.5\times$  wing length, fringe setae c.  $0.1\times$  FWW; MV curving posteriorly at base to meet PM, rather abruptly angling apically to form SV; MV relatively short, c.  $0.8\times$  length of SV and PM, resp., with 3 elongate setae dorsally; PM slightly disjunct from MV, with 2 strong setae, lacking a radial process; postmarginal vein absent; costal cell well developed, with a row of c. 10 dorsal setae along anterior margin and several scattered ventral setae behind; disk densely setose, setal tracks R, RS2, r-m, M and Cu1 present, all except R somewhat obscured by surrounding setae, RS1 setae not distinct from surrounding setation, a basal vein track absent. Hind wing broad, cultriform, posterior fringe only c.  $0.6\times$  HWW; disk densely setose, without distinct linear tracks. First tarsomere of mid-leg similar in length to second and third. Ovipositor elongate but not extending appreciably behind apex of metanotum, gonoplac short, OL/HTL = 1.9; hypopygium extending only c. 0.5 length of ovipositor.

*Male.* As female except funicular segments slightly longer and narrower, and with FS on F1; FS longer on all segments, longest c.  $2.7\times$  maximum antennal width. Genitalia  $3.4\times$  as long as wide, VS and IVP extending well beyond apex of PAR; without ventral protuberances at base of PAR. AL slightly longer than GL, AL/HTL = 0.7.

*Types.*—Holotype ♀ and allotype ♂. UNITED STATES. *Utah*: Washington Co., Snow Canyon State Park, c. 1.0 mi. N. Ivins; iii-29-1989; sweeping *Rhus*, *Quercus*, *Lycium*, and *Fraxinus*; J. D. Pinto, collr.; in NMNH.

*Etymology.*—In memory of the American poet, Robinson Jeffers.

*Material examined.*—3♀, 3♂ (all on slides). UNITED STATES. *New Mexico*: Hidalgo Co., Animas Mts. (east slope) (Gray Ranch: Indian Creek wash, N. of Culberson Camp), 31° 25.306'N, 108° 40.525'W; viii-5-2002; SP; 1♂; J. George/M. Gates. Hidalgo Co., San Luis Pass (Gray Ranch: N. side of Pleistocene lake bed), 31° 25.556'N, 108° 50.057'W; SP; 1♀; M. Gates. *Texas*: Brewster Co., Big Bend National Park, Rosillos Mts. (Buttrill Spring); iii-17/21-1992; 1♀; J. Woolley/R. Wharton. Brewster Co., Big Bend National Park; 29° 34' 22" N, 103° 16' 19" W; viii-18/21-1992; 1♂; J. Woolley/R. Wharton. *Utah*: Washington Co.; 1♀, 1♂ (see Types).

*Comments.*—*Ceratogramma jeffersi* is the most generalized species in the genus, lacking virtually all derived features characterizing the other New World species (i.e. all characters listed in Table 1 in Pinto and Viggiani 1991 are absent). In the key to species presented in 1991, *C. jeffersi* runs unsatisfactorily to *C. etiennei* and *C. brasiliense* in couplet 5. The absence of a postmarginal vein, radial process, basal vein track and a fourth club segment in males separate it from both.

### 3. *Haeckeliania* Girault (Figs 2, 26, 27, 109, 189, 209)

*Haeckeliania* Girault 1912. Type species: *Haeckeliania haeckeli* Girault, by original designation.



**Diagnosis.**—*Female.* Antenna with 2 anelli and a 5-segmented club; club widest at C1, often terminating in a short terminal process, with at least some PLS extending beyond surface for c. half their length or more. Maxillary palp 2 segmented. Fore wing varying in width, commonly relatively broad; venation usually not attaining half FWL, MV gradually broadening to apex and longer than wide, considerably less than 3× as wide as PM (may be slightly narrower than PM), PM slightly shorter to, more commonly, slightly to considerably longer than MV, diverging posteriorly to form a distinct costal cell, SV well developed, attached to the posteroapical corner of MV; disk moderately densely setose usually with distinct linear setal tracks, RS1 usually present, radial process present. Midlobe of mesoscutum and scutellum each with 2 pair of setae, notauli usually broadly arcuate. Metasomal tergum I (petiolar) with a transverse row of denticles.

*Male.* Antenna with all PLS attached to surface at base only, spiniform, erect. GC completely open dorsally; PAR and VS present, PAR bifid apically; ADG usually longer than GC.

**Distribution.**—Widespread except not recorded from Europe; greatest diversity appears to be in tropical areas.

**Diversity.**—There are nine species of *Haeckeliania* described; only two, *H. sperata* Pinto, from the West Indies and *H. minuta* Viggiani, from Brazil, occur in the New World. The remainder are from Asia and Australia. *Haeckeliania sperata* was recently introduced into Florida for control of *Diaprepes* root weevil (Hall et al. 2001). As indicated by Pinto (2005), *Haeckeliania* is one of the largest genera of Trichogrammatidae with the vast majority of species, including many from the New World, awaiting description.

**Discussion.**—*Haeckeliania* is distinguished by the five-segmented club with its relatively wide C1 and PLS which are largely (females) or completely (males) free of the antennal surface, the two-segmented max-

illary palp, the transverse row of denticles on the petiolar tergum, and fore wing characteristics. It appears closest to *Brachyufens*, which is separated by the very short, quadrate marginal vein (as wide as long), and the midlobe of the mesoscutum bearing three rather than two pair of setae. The only other New World genus with a five segmented club and a two-segmented maxillary palp is *Trichogrammatella*. The latter is distinguished by its elongate stigmal vein, spinose fore tibiae and antennal PLS which extend minimally beyond the surface. The Old World *Ophioneuris* and Asian *Eutrichogramma* are similar phenetically to *Haeckeliania*; they are separable by PLS structure (all attached to antennal surface most of their length in both sexes) and the absence of a row of denticles on the petiolar tergum.

As noted previously (Pinto 2005) there are two general phenotypes of *Haeckeliania* species in the New World. In one, characterized by *H. minuta*, the body is compact, gibbous, and uniformly dark brown in color. In a less diverse group characterized by *H. sperata*, the body is more slender and lighter in color.

**New World records.**—**Argentina:** Chaco, La Rioja, Misiones, Salta. **Belize.** **Bolivia.** **Brazil:** Mato Grosso, Minas Gerais, Rondonia, Santa Catarina, São Paulo. **Canada:** Manitoba, Quebec. **Colombia.** **Costa Rica.** **Ecuador.** **Guatemala.** **Mexico:** Baja California Sur, Chiapas, Colima, Guerrero, Jalisco, Michoacan, Nuevo Leon, Quintana Roo, Sinaloa, Tamaulipas, Yucatan. **Nicaragua.** **Panama.** **Peru.** **United States:** Arizona, California, Florida, Georgia, Illinois, Maryland, Missouri, North Carolina, South Carolina, Virginia, West Virginia. **Venezuela.** **West Indies.**

**Hosts.**—*Coleoptera:* Curculionidae (Pinto 2005).

#### 4. *Hydrophylita* Ghesquière (Figs 15, 114a/b, 170, 203, 204)

*Hydrophylax* Matheson and Crosby 1912. Type species: *Hydrophylax aquivolans* Matheson and Crosby, by original designation.

*Hydrophylita* Ghesquière 1946 (n. n. for *Hydrophylax* Matheson and Crosby, nec *Hydrophylax* Fitzinger 1843).

*Lutzimicron* Costa Lima 1960. Type species: *Lutzimicron lestesi* Costa Lima, by monotypy. Doult and Viggiani (1968, as *Lutzimicron*, synonymy). Herein as valid subgenus. **New status.**

**Diagnosis.**—Body shape slender, elongate; eyes dark red in color. *Female.* Antenna elongate, with 1 or 2 anelli, 2 funicular and usually 3 club segments; all postantennal segments longer than wide; funicular segments and often club segments loosely articulated; PLS absent from funicle; BPS extremely elongate, narrow, often apically attenuate; apex of female club with two large unsocketed spatulate sensilla. Mandible with a very large posterior spine. Maxillary palp 1 or 2 segmented. Midlobe of mesoscutum and scutellum each with 2 pair of strong setae. Propodeum elongate, almost as long as to distinctly longer than scutellum, subrectangular. Fore wing elongate, narrow, 5–10× as long as wide; disk sparsely to extremely densely setose (sparsely setose wings with setae linearly arranged, densely setose wings without linear tracks).

*Male.* Antenna with funicular segments longer; club longer with segments less closely appressed. GC completely open dorsally, with distinct PAR and VS, IVP absent.

**Distribution.**—New World, southern Africa, SE Asia, Australia. Previously known only from the New World.

**Diversity.**—Three species, all New World. See Discussion.

**Discussion.**—*Hydrophylita* cannot be confused with any other genus. Although superficially similar to certain Oligositini such as *Prestwichia* and *Sinepalpigramma*, it is easily separated by the two-segmented funicle (one segmented in oligositines), very dark but reddish eyes (black in oligositines), two pair of setae on the mesoscutellar midlobe and scutellum (one pair on both in oligositines) and the

generalized male genitalia (highly reduced in oligositines). The two large sensilla at the apex of the female club (Fig. 15) and the greatly enlarged posterior mandibular spine in both sexes (Fig. 170) also help distinguish the genus.

There are three species of *Hydrophylita* described, all from the New World. *H. aquivolans* from the United States and Canada, and *H. bachmanni* De Santis from South America have very narrow fore wings (c. 10× as long as wide) which taper to a point at their apex (Fig. 114A), a one-segmented maxillary palp, and a propodeal length subequal to that of the scutellum. They also have a uniquely shaped aedeagus which is enlarged and spatulate apically (see Viggiani 1971, Fig. 6). The two are distinguished by the number of anelli – one in *H. aquivolans*, two in *H. bachmanni*. *H. lestesi* Costa Lima and related undescribed species, also from South America, differ considerably from both by the broader and densely setose fore wing (c. 5× as long as wide) which is rounded apically (Fig. 114B), a much longer propodeum (> length of scutellum), exerted and spiniform PLS in females, a two-segmented maxillary palp, and an unmodified aedeagus. *H. lestesi* was placed in its own genus, *Lutzimicron*, by Costa Lima (1960) but subsequently synonymized with *Hydrophylita* by Doult and Viggiani (1968). It is herein treated as a valid subgenus (**new status**) based on the considerable morphological differences.

The nominate subgenus is known only from the New World; all extralimital collections of the genus represent *Lutzimicron*. Both subgenera occur throughout Central and South America. I am not aware of records from Mexico, and only the nominate subgenus is recorded north of there in SE Canada and NE United States. In at least one New World species of *Lutzimicron* C2 and C3 are partially fused in females; in females of undescribed species from Madagascar and Indonesia these segments are completely fused and

the club is two segmented. The fore wing also may be wider in certain extralimital species (c.  $4\times$  as long as wide).

*New World records.*—Subgenus indication follows each record (H = nominate subgenus, L = *Lutzimicron*). **Argentina:** Buenos Aires (H). **Belize** (H/L). **Bolivia** (H/L). **Brazil:** Amazonas (L), Goiás (H/L), Rio de Janeiro (L). **Canada:** Ontario (H). **Colombia** (H/L). **Costa Rica** (H/L). **Ecuador** (H/L). **Guatemala** (H). **Panama** (H/L). **United States:** New York (H). **Venezuela** (L). **West Indies** (L).

*Hosts.*—Odonata: Coenagrionidae [Matheson and Crosby 1912, for *H. (H.) aquivolans*], Lestidae [Costa Lima 1960, for *H. (L.) lestesi*].

### 5. *Mirufens* Girault

(Figs 16, 17, 101, 102, 173, 178, 205, 206)

*Mirufens* Girault 1915. Type species: *Mirufens dentipes* Girault, by original designation.

*Trachocera* Blood and Kryger 1928. Type species: *Trachocera longicauda* Blood and Kryger (junior objective synonym of *Asynacta longicauda* Blood), by original designation. Doult and Viggiani 1968 (as valid subgenus). Neto and Pintureau 1997 (synonymized with nominate subgenus).

*Pseudotrachocera* Neto and Pintureau 1997 (as subgenus). Type species: *Trachocera gundlachi* Nowicki, by original designation.

*Diagnosis.*—Relatively elongate. *Female.* Antenna with 2 anelli, 2 funicular and 3 club segments; postanellar segments with relatively few FS; pedicel transversely ridged, ridges crenulate; funicular segments distinctly separated from one another, F1 often somewhat longer than F2. Maxillary palp 2 segmented. Midlobe of mesoscutum and scutellum each with 2 pair of elongate setae. Fore wing relatively broad,  $< 2\times$  as long as wide; venation with SV elongate, usually subequal to or longer than MV, basal SV width commonly similar to apical width of MV, PM subequal in length to MV; disk usually moderately densely setose with linear setal tracks present including RS1, tracks some-

times difficult to discern in species with denser setation. Fore tibia with a row of thorn-like spines on dorsal surface.

*Male.* Antennal club with a short fourth segment, postanellar segments dominated by elongate FS. GC open its entire length, with VS and PAR, without an IVP.

*Distribution.*—Widespread. Occurring from Alaska south to Guatemala in the New World, with a single South American record (Chile).

*Diversity.*—Sixteen species are placed in *Mirufens*; none is from the New World although several occur here. Because *Mirufens* is relatively homogeneous morphologically, I hesitate formally describing New World representatives without further study of named Palearctic species.

*Discussion.*—*Ufens* and *Ceratogramma* are most likely confused with *Mirufens*. As in *Mirufens*, males of *Ufens* and certain species of *Ceratogramma* have an antennal club with a small fourth segment. *Ufens* is easily distinguished by the one-segmented maxillary palp. Also the male genitalia differ considerably. In *Mirufens* the genitalia are typical of the Trichogrammatini (Type 1) in that the aedeagus is separate from the genital capsule, and the latter is completely open dorsally. Although genital structure varies greatly in *Ufens*, the genital capsule is not open its entire length dorsally and the aedeagus is not distinct. *Ceratogramma* and *Mirufens* have similar genitalic structure but the former is characterized by an elongate intervolsellar process which is absent in *Mirufens*. Anellar structure also separates *Ceratogramma*. In addition, both *Ceratogramma* and *Ufens* lack the spinose fore tibia, and the transversely ridged, crenulate pedicel. *Mirufens* probably is most closely related to *Pseudomirufens* described from China (Lou and Yuan 1998) and also occurring in Australia (Pinto, unpubl.). The fewer club segments in the male, and the much shorter second funicular segment separate that genus from *Mirufens*. The New World *Trichogrammatella* may also be related (see below).



Doutt and Viggiani (1968) divided *Mirufens* into two subgenera, the nominate subgenus and *Trachocera*. The nominate group included species with the marginal vein failing to contact the anterior border of the fore wing, a more distinct separation between the marginal and premarginal veins, and a longer stigmal vein. *Trachocera* included species with the marginal vein coinciding with the anterior wing margin and more elongate club and funicular segments. Neto and Pintureau (1997), noting several intermediate conditions, did not recognize this division and instead returned all species to the nominate subgenus except the Palearctic *M. gundlachi* which they placed in its own subgenus, *Pseudotrachocera*, primarily based on its narrower fore wings.

*New World records.*—**Canada:** Alberta, British Columbia, Manitoba, Ontario, Quebec. **Chile:** Region X (Isla Chiloé). **Guatemala.** **Mexico:** Guerrero, Jalisco. **United States:** Alaska, Arizona, California, Colorado, Maryland, Michigan, Montana, North Carolina, Nevada, New Mexico, Oklahoma, Oregon, South Carolina, Texas, Utah, Virginia, Washington, West Virginia, Wisconsin.

*Hosts.*—Hemiptera: Membracidae, Cica-dellidae (Neto and Pintureau 1997).

## 6. *Pachamama* Owen and Pinto (Figs 18, 19, 103)

*Pachamama* Owen and Pinto 2004. Type species: *Pachamama speciosa* Owen and Pinto, by original designation.

*Diagnosis.*—*Female.* Compact, gibbose in shape. Antenna with 2 anelli and a 3-segmented club; C3 much longer than C1 and C2 combined; scape elongate, c.  $3\times$  as long as wide. Mandible with a socketed anterior tooth. Maxillary palp 1 segmented. Fore wing broad, c.  $1.8\times$  as long as wide, posterior margin with a distinct preretinal lobe, venation extending c. 0.7 FWL, fringe setae c.  $0.3\times$  FWW; venation confluent, sigmoid with greatest curvature at

base (from CS to MV), SV relatively short and diverging little from MV and wing margin; disk sparsely setose, setae primarily restricted to apical third of wing and not clearly arranged in linear tracks posterior to the r-m, RS1 absent, costal cell large but without setae. Hind wing broad, subtriangular, anterior margin broadly V-shaped basal to hamuli. Both fore and hind wing fumate except at apex. Mesophragma not notched apically. First metasomal tergum without a transverse row of denticles.

*Male.* Antenna with scape extremely enlarged, suboval, c.  $1.5\times$  as long as wide, its width greater than length of club. GC trough-like, completely open dorsally, with distinct PAR and VS, IVP absent.

*Distribution.*—Central and NW South America.

*Diversity.*—Monotypic.

*Discussion.*—*Pachamama* is one of the most easily recognizable genera of Trichogrammatidae. Its gibbose body shape, three-segmented club with C3 longer than C1 and C2 combined, the sexually dimorphic scape (enormously inflated in the male), and fumate fore wing with basally sigmoid venation and a distinct preretinal lobe will separate it from all other genera. *Pachamama* is not obviously related to any other group. Other Trichogrammatini genera sharing its compact and robust body shape include *Cerato-gramma*, *Poropoea*, and most *Haeckeliania*. Antennal structure alone separates all three; the former two have a distinct funicle, and all have at least five postantennal segments in both sexes. Also, unlike *Pachamama*, all three genera have a two-segmented maxillary palp. Certain species of *Adryas* also may be confused with *P. speciosa*. In addition to lacking the strongly dimorphic antenna and preretinal lobe on the fore wing, venation in *Adryas* species easily separate them. In *Adryas* the venation is not sigmoid basally; instead it is quite straight with the premarginal vein approaching the anterior wing margin (cf.

Figs 103, 140). Male genitalia also are greatly reduced in *Adryas* (Type 2a) which places it in the Oligositinae.

**Records.**—**Costa Rica. Ecuador. Honduras.** See Owen and Pinto (2004) for specific collection records.

**Hosts.**—Unknown.

### 7. *Paratrichogramma* Girault (Figs 28, 29, 110, 188, 210, 211)

*Paratrichogramma* Girault 1912. Type species: *Paratrichogramma cinderella* Girault, by original designation.

**Diagnosis.**—**Female.** Antenna with only 3 or 4 flagellomeres: 1 or 2 anelli, 1 funicular and 1 club segment; club with a patch of RS apicoventrally; F1 abruptly narrowed at apex. Mandible without a socketed anterior tooth. Fore wing slightly more than 2× as long as wide; venation short, abbreviated, attaining 0.4 FWL, MV placed slightly posterior to anterior wing margin, SV reduced to a small sessile appendix of MV; disk sparsely to moderately densely setose with very few setae in basal half, linear setal tracks present apically, RS1 absent. Mesophragma entire, not notched apically. Metasomal tergum I (petiolar) with a transverse row of denticles.

**Male.** Antenna with 2 funicular segments, F2 abruptly and asymmetrically narrowed apically ('bottle shaped'), club without patch of RS ventroapically. GC with a narrow transverse bridge dorsal to ADG at middle, PAR and VS present, PAR bifid apically; ADG subequal in length or only slightly longer than GL, AAP fused basally.

**Distribution.**—In New World from SW United States S to Costa Rica with a single record from Argentina. Also known from Australia, southern Africa, Israel and India.

**Diversity.**—Eight species of *Paratrichogramma* have been described. Only one, *P. californica* Doult, occurs in the New World. All New World collections examined are conspecific or very close to *P. californica*.

**Discussion.**—*Paratrichogramma* cannot be confused with any other genus. Its anten-

nal formula (Figs 28, 29) and distinctive fore wing (Fig. 110) allow easy recognition. Its fore wing venation is superficially similar to that in *Aphelinoidea* and *Tumidiclava*, but in these genera the marginal vein contacts the anterior wing margin, and the disk is more densely setose and lacks linear setal tracks. *Paratrichogramma* may be closest to the Australasian *Brachyia* and *Australufens*. All three have the aedeagal apodemes fused basally (Fig. 210) as well as a patch of RS on the club. *Brachyia* has similarly abbreviated venation.

**New World records.**—**Argentina:** Formosa. **Costa Rica. Mexico:** Baja California Sur, Campeche, Jalisco, Michoacan, Nuevo Leon. **United States:** Arizona, California, Texas, Utah.

**Hosts.**—Lepidoptera: Gracillariidae (Hayat and Viggiani 1984), Noctuidae (Viggiani 1976a), Lycaenidae (Pinto, unpubl.).

### 8. *Poropoea* Förster (Figs 20, 104)

*Poropoea* Förster 1851. Type species: *Poropoea stollwerckii* Förster, by monotypy.

*Poropoeoides* Nowicki 1936 (as subgenus). Type species: *Poropoea bohemica* Nowicki, by monotypy.

**Diagnosis.**—Large for family, commonly 1 mm or more in length, gibbose in shape. **Female.** Antenna with 2 anelli, 2 funicular and 3 club segments; funicular segments longer than wide, loosely articulated, funicle elongate varying from almost as long to distinctly longer than club. Maxillary palp 2 segmented. Mesophragma relatively short, not notched apically. Fore wing broad, oblate apically, < 2× as long as wide; venation narrow, veins confluent, strongly sinuate, with SV elongate and almost perpendicular to MV, MV not contacting anterior margin of wing, its width subequal to that of SV; disk sparsely to moderately densely setose, linear setal tracks distinct including RS1.

**Male.** Antenna with all postanellar segments longer than wide, usually loosely

articulated and not obviously consolidated into a distinct funicle and club; segments without whorls of elongate FS. GC completely open dorsally, basal margin indistinct, with VS, PAR and an elongate IVP; ADG somewhat longer than GC.

*Distribution*.—Widespread except not recorded from Australia. Known in the New World from E Canada to Brazil.

*Diversity*.—*Poropoea* includes 14 described species. Only one, *P. attelaborum* Girault, from the eastern United States, is described from the New World. All others are from Europe and Asia. A small number of apparently undescribed species occur in the New World. See Subba Rao (1969) and Kobayashi and Kato (2004) for keys to species.

*Discussion*.—*Poropoea* is immediately recognizable by its fore wing venation. It is displaced from the anterior margin of the wing, confluent and strongly sinuate with the stigmal vein virtually perpendicular to the marginal vein. This coupled with antennal structure insures identification. *Mirufens* and *Ceratogramma* are somewhat similar to *Poropoea*. *Poropoea* is separated from both by its narrow and sinuate venation, and its unconsolidated club in New World males. It is further separated from *Mirufens* by its unnotched mesophragma and male genitalia with an intervalsellar process. From *Ceratogramma* it also differs in having two, not three anelli.

Nowicki (1936) divided the genus into subgenera, the nominate and the monotypic *Poropocoides*. The latter, based on the European *P. bohémica*, was distinguished by the consolidated club in males. As indicated, in most *Poropoea* the club and funicular segments are loosely articulated. Doult and Viggiani (1968) did not recognize the distinction taxonomically, but did not formally synonymize *Poropocoides*.

*New World records*.—**Belize. Brazil:** Amazonas. **Canada:** Quebec. **Costa Rica. Ecuador. United States:** Florida, Missouri. **West Indies.**

*Hosts*.—Coleoptera: Atellabidae (Girault 1911c, Nowicki 1936, Kobayashi and Kato

2004). Both subgenera are known from atellabids.

### 9. *Pterandrophysalis* Nowicki (Figs 22, 23, 105, 106, 207)

*Pterandrophysalis* Nowicki 1935. Type species: *Pterandrophysalis levantina* Nowicki, by original designation.

*Diagnosis*.—*Female*. Antenna with 2 anelli, 2 funicular and 3 club segments; funicular segments distinctly separated from one another and from club. F1 anelli-form, much wider than long; F2 subquadrate, with 2 PLS, c. 4× as long as F1, and c. 1.3× as wide; club widest near junction of C1 and C2, both segments subequal in length, C3 slightly shorter, subconical. Maxillary palp 2 segmented, segment I shorter than II but distinctly wider. Fore wing slightly more than 2× as long as wide; venation with MV short, shorter than PM, of normal width, SV distinct, constricted between stigma and MV, radial process present; disk densely setose, without distinct setal tracks, RS1 absent.

*Male*. Antenna with F1 somewhat larger than in female, subequal in width to F2, F2 shaped as in female but smaller and without PLS. Fore wing with MV and PM consolidated, enormously inflated, occupying almost entire basal width of wing. GC completely open dorsally, with PAR and VS, IVP absent; ADG longer than GC.

*Distribution*.—Europe, north Africa and Middle East; known from central California (see Discussion).

*Diversity*.—Monotypic.

*Discussion*.—*Pterandrophysalis* is easily separated from all other Trichogrammatidae. The extent of venation inflation in the male fore wing is unique (cf. Figs 105, 106). Although an inflated venation is known in males of certain other genera (e.g. *Adryas*), in none of these does the expansion span almost the entire basal width of the wing. In the New World *Pterandrophysalis* is most similar to *Ceratogramma*. Males are easily separated by fore



wing venation. In addition, the genital capsule of *Pterandrophysalis* lacks an inter volsellar process, a prominent feature in *Ceratogramma*. Both sexes of *Pterandrophysalis* can be distinguished by the antennal formula. Whereas *Ceratogramma* has three anelli, *Pterandrophysalis* has only two.

*Pterandrophysalis* appears to represent little more than a species of *Szelenyia* with strongly modified venation in males. All other characters suggest synonymy. The male genitalia are nearly identical (Viggiani, 1971, 1984), wing venation (excluding males of *P. levantina*), discal setation of both pairs of wings, and antennal formula also are similar in both (see Doutt and Viggiani 1968). Synonymy is not formalized here, however, pending a more complete study of Old World taxa. Also see *Ceratogramma* above.

*Pterandrophysalis* is monotypic. The type species, *P. levantina*, described from Turkey and Syria (Nowicki 1935) also is known from Italy, Greece and Tunisia (Pinto, unpubl.). Recent collections by S. L. Heydon (UCDC) from the Cold Canyon Reserve in Solano Co., California, can not be separated from *P. levantina*. Its occurrence in California represents a likely Old World introduction possibly associated with the release of various exotic curculionid species for control of yellow starthistle (*Centaurea solstitialis* L.). *P. levantina* has been collected in Greece from eggs of *Bangasterinus orientalis* (Capiomont) (Pinto, unpubl.); the latter is one of the Old World species of weevil introduced and now apparently established in California (Pitcairn 1996).

**New World records.**—**United States:** California.

**Hosts.**—Coleoptera: Curculionidae (unpubl.).

#### 10. *Soikiella* Nowicki

(Figs 7, 8, 30, 31, 111, 212–214)

*Soikiella* Nowicki 1933. Type species: *Soikiella mongibelli* Nowicki, by original designation. Velten and Pinto 1990 (generic review).

**Diagnosis.**—**Female.** Antenna with 1 anellus, 1 funicular and 3 club segments, club with a short terminal process; C2 and C3 asymmetrical, C3 asymmetrically narrowed to apex, dorsal surface straight from base to apex, ventral surface convex with a patch of RS apically; postanellar segments with few PLS attached to the antennal surface almost their entire length; club segments with FS. Midlobe of mesoscutum and scutellum each with two pair of elongate setae. Fore wing broad, c. 1.6× as long as wide; venation short, attaining c. 0.4 FWL, PM and MV confluent, SV short and broad with only a slight constriction between stigma and MV; disk moderately densely setose with linear setal tracks but RS1 absent. Metasomal tergum I (petiolar) with a transverse row of denticles. Ovipositor short, broad, its length <0.75 HTL.

**Male.** Antenna differing considerably from female: with 2 funicular and 3 club segments, club segments symmetrical, C3 without a terminal process; all postanellar segments with several stout, erect, spiniform PLS. GC broad, deep, PAR and VS present; ADG appearing distinct from GC under light microscope but actually connected at its sides; AAP almost perpendicular to body of ADG (see Discussion).

**Distribution.**—Western North America, Asia and Europe.

**Diversity.**—There are three species of *Soikiella*, *S. occidentalis* Velten and Pinto, from the United States and Canada, *S. mongibelli* from Europe and the Middle East, and *S. asiatica* Lou and Yuan, from Asia.

**Discussion.**—*Soikiella* is separated from other New World genera by its sexually dimorphic antennae, and fore wing structure. The single funicular segment coupled with three club segments as found in females occurs only in *Pintoa*, the Oligositini and *Bloodiella*. Its broad fore wing separates it from the former two, and the absence of an RS1 separates it from the

atter. In addition, these other taxa lack similarly sexually dimorphic antennae.

*Soikiella* is not obviously related to any other genus. Fore wing and female antennal structure suggest affinity to *Bloodiella*, however the male antennae and genitalia are considerably different in the two (Velten and Pinto 1990). The position of the apodemes at approximate right angles to the aedeagus (Fig. 213) is a feature known only in this genus. *Soikiella* is somewhat annectant between the Trichogrammatinae and Oligositinae, and placement in the former is arbitrary. As indicated earlier, the aedeagus appears distinct from the genital capsule under the light microscope and in certain views with SEM examination as well (Fig. 212) suggesting Trichogrammatinae. Other SEM preparations show possibly flexible lateral connections to the apex of the capsule (Fig. 213) suggesting oligositine affinity. This feature does not resemble the complete aedeagus/genital capsule consolidation typical of the Oligositinae however. *Soikiella* is placed in the Trichogrammatinae for this reason and the fact that the tergum of its petiolar segment bears a transverse band of denticles as do several other genera in that subfamily. The molecular evidence also suggests intermediacy to the two subfamilies (Owen et al., in prep.).

*New World records.*—**Canada:** Alberta, British Columbia. **United States:** Arizona, California, Texas, Washington, Wyoming.

*Hosts.*—Diptera: Asilidae (Velten and Pinto 1990).

# 11. *Thanatogramma* Pinto, new genus (Figs 32, 33, 112, 215–217)

*Type species.*—*Thanatogramma oweni* Pinto, n. sp.

*Description.*—*Female.* Antenna with 2 segments, and a 2-segmented funicle and club, funicular segments well separated, F2 shorter than F1, club segments closely appressed, C2 with apicoventral surface convex, with a patch of RS. Mandible with

3 posterior teeth and 1 elongate, socketed anterior tooth. Maxillary palp 1 segmented. Midlobe of mesoscutum and scutellum each with 2 pair of moderately long setae (broken in female, based on males); propodeum narrow, only slightly longer than metanotum, strap-like, not modified into a longer or elevated discal area at middle; mesophragma not notched apically. Fore wing relatively wide, less than  $2\times$  as long as wide, fringe setae short, the longest c.  $0.1\times$  FWW; venation with MV slightly longer than PM, PM and MV disjunct, SV well developed with a constriction between stigma and MV; disk moderately densely setose, with setal tracks poorly indicated, RS1 absent, setation extending basally to area behind MV. Hind wing with 3 linear setal tracks. Metasomal tergum I (petiolar) with a transverse row of denticles. Ovipositor short, length less than HTL.

*Male.* Differing from female in antennal structure. Club 3 segmented and funicular segments longer and wider. Genitalia generalized: ADG distinct, not fused to GC and considerably longer, aedeagal AAP not fused at base; GC with distinct VS and PAR, IVP absent; GC not completely open dorsally, with a relatively short subtriangular sclerotized DLA near apex and above the ADG forming the posterior border of an elongate ADA.

*Etymology.*—Death drawing or image. From, Thanatos, ancient Greek god of death; gramma (Gr.), common ending for trichogrammatid genera signifying 'lines', 'that which is drawn', etc.; gender neuter.

*Distribution.*—Known only from a single locality in eastcentral California.

*Diversity.*—Monotypic.

*Discussion.*—The sexually dimorphic antennal formula (2F, 3C in ♂; 2F, 2C in ♀) along with characteristics of the funicle (F1 and F2 distinctly separated, relatively elongate and loosely articulated), fore wing (relatively broad [ $< 2\times$  as long as wide], short fringe setae [c.  $0.1\times$  FWW], distinct SV with constriction between stigma and MV), and maxilla (single segmented) sep-

arate *Thanatogramma* from all other trichogrammatid genera.

The new genus is most similar to *Trichogrammatomyia*, and the Australasian *Brachyia* and *Australufens* all of which have similar antennal structure. From *Trichogrammatomyia* it is separated by its broader wing and much shorter fringe setae (cf. Figs 112, 115), as well as the longer parameres relative to the volsellae (cf. Figs 217, 222). Also all species of *Trichogrammatomyia* except *T. tortricis* have only a single club segment. These features also separate *Australufens*. From *Brachyia*, *Thanatogramma* is separated by its one-segmented maxillary palp and distinct stigmal vein (the stigma is abbreviated and sessile to the MV in *Brachyia*). The male genitalia of *Brachyia* have a similarly elongate aedeagus but its apodemes are fused basally, not separated as in *Thanatogramma*. Also, *Thanatogramma* is the only one of these genera to have a socketed anterior mandibular tooth, an apically unnotched mesophragma and a dorsal lamina above the aedeagus. These features also occur in *Trichogramma*, a genus differing considerably in fore wing structure (cf. Figs 112, 113).

**Records.**—**United States:** California (see below for specific records).

**Hosts.**—Unknown.

### *Thanatogramma oweni* Pinto, new species

**Description.**—Body length c. 0.6 mm (from slides), color uniformly dark brown except tarsi, base of tibiae and vertex of head slightly lighter. **Female** (N=2). Antenna (Fig. 32) with scape elongate, subequal in length to club,  $4.3\times$  as long as wide; pedicel half the length of scape, c. twice as long as wide; funicular segments subquadrate, each segment less than half as long as pedicel, F1 as long as wide, slightly longer than F2, F2 wider than long, both segments equally wide, only half the maximum width and  $0.4\times$  maximum length of club; A2 closely appressed to

F1; club  $2.7\times$  as long as wide, suboval, C2 twice the length of C1, with apicoventral patch of RS occupying 0.6 its length; funicle and club covered with moderately dense and stiff APA; funicle without PLS; club with 1 and 6 PLS on C1 and C2, respectively; a single short subglobose BPS at apex of F1, F2 and C1; UPP at apex of C2 setiform, about the same length as adjacent RS; FS absent from funicle, sparse on club. Mandible with socketed anterior tooth less sclerotized but as long as unsocketed posterior teeth. Maxillary palp slightly over twice as long as wide, apical sensillum spiniform, c. half the palpal length. Mesosoma with relatively large, finely etched reticulae dorsally, without obvious intrareticular sculpturing; midlobe of mesoscutum c.  $1.75\times$  the length of scutellum; propodeal spiracles at anterior edge of tergum; tarsi shorter than tibiae, all apical tibial spurs distinctly shorter than first tarsomere. Fore wing (Fig. 112)  $1.8\times$  as long as wide; venation extending c. 0.5 FWL, longest fringe setae c.  $0.1\times$  FWW, MV c.  $1.2\times$  length of PM and c.  $2.7\times$  as long as wide, MV slightly wider than PM, PM with 2 setae and 2 campaniform sensilla at apex, SV slanted posteroapically with a distinct constriction between MV and stigma, costal cell well developed, with 2 setae. Hind wing with 3 linear setal tracks, scattered setae between middle and posterior tracks, posterior track not attaining apex of wing. Ovipositor short, broad, OL/HTL = 0.66; hypopygium not apparent.

**Male.** Differing from female as follows: Antenna (Fig. 33) with club 3 segmented; funicular segments both slightly longer than wide, subequal in length and width, each segment c.  $0.7\times$  length of pedicel, funicle c.  $0.7\times$  the length and  $0.8\times$  the width of club; club distinctly longer than scape, club segments more loosely associated, C1 slightly longer than wide, C2 slightly longer than other club segments, c.  $1.6\times$  as long as wide, C3 subconical,  $1.8\times$  as long as wide; elongate FS dominating antennal surface of all postanellar seg-



nents, representing the only setiform structures except for a single ATB at apex of C1, longest FS c.  $2\times$  maximum club width; 1 PLS present on each club segment. Genitalia (Figs 215–217) with GC  $2.3\times$  as long as wide, PAR extending considerably beyond VS, IVP absent, basal margin of GC indistinct, ADA elongate, c. 0.7 the length of GC, DLA short, c.  $0.2\times$  GC length; ADG  $0.6\times$  as long as GC, AAP comprising at least 0.5 length of ADG, not fused basally, AL/HTL 0.82–1.05 (N=2).

*Types*.—Holotype ♀. UNITED STATES. California: Inyo Co., Panamint Valley, Warm Sulphur Springs;  $36^{\circ} 07.15' N$ ,  $117^{\circ} 12.91' W$ ; v-17-2002; "YPT near mesquite and *Allenrolfea*"; A. Owen/J. Pinto, collrs.; in NMNH. Allotype ♂. Same as holotype except -  $36^{\circ} 07.159' N$ ,  $117^{\circ} 12.874' W$ ; vi-21/22-2002; "YPT around tamarisk and mesquite"; J. George/A. Owen, collrs.; also in NMNH. Two paratypes as follows: 1♀, data same as holotype except labeled as - Indian Ranch Road, c. 1.5 mi. S; Warm Sulphur Springs;  $36^{\circ} 07.48' N$ ,  $117^{\circ} 12.83' W$ ; v-15-2003; "screen sweep mesquite, *Allenrolfea*, etc."; J. Pinto, collr.; UCRC. 1♂, locality as ♀ paratype except no coordinates indicated and collected v-20-1991; "screen sweeping *Prosopis* and *Anemopsis*"; J. Pinto, collr.; UCRC.

*Etymology*.—After Albert K. Owen, who made considerable effort to collect this uncommon species.

*Comments*.—*T. oweni* is known only from the type material. The female paratype is a molecular voucher (Owen et al., in prep.) and is represented on a slide by a fore wing and an antenna.

## 12. *Trichogramma* Westwood

(Figs 9, 34, 35, 113, 169, 194, 198, 199, 218, 219)

*Trichogramma* Westwood 1833. Type species: *Trichogramma evanescens* Westwood, by monotypy. Sorokina 1993 (key to world species). Pinto 1999 (revision of North American species).

*Calleptiles* Haliday 1833. Type species: *Calleptiles latipennis* Haliday, by monotypy.

*Pentarthron* Packard 1872. Type species: *Trichogramma minutum* Riley, by monotypy.

*Aprobosca* Westwood 1878 (as subgenus). Type species: *Trichogramma (Aprobosca) erosicornis* Westwood, by monotypy.

*Oophthora* Aurivillius 1897. Type species: *Oophthora semblidis* Aurivillius, by monotypy.

*Xanthoatomus* Ashmead 1904. Type species: *Xanthoatomus albipes* Ashmead, by monotypy.

*Neotrichogramma* Girault 1911. Type species: *Neotrichogramma acutiventris* Girault, by original designation.

*Trichogrammatana* Girault 1932 (as subgenus). Type species: *Trichogramma singularis* Girault, by monotypy.

*Trichogrammanza* Carver 1978 (as subgenus, currently valid). Type species: *Trichogramma funiculatum* Carver, by original designation.

*Nuniella* Kostadinov 1988. Type species: *Nuniella bistrata* Kostadinov, by original designation. Pintureau 1993 (as synonym).

*Vanlisus* Pinto 1992 (as subgenus, currently valid). Type species: *Trichogramma lachesis* Pinto, by original designation.

*Diagnosis*.—*Female* (all subgenera). Antenna with 2 anelli, 2 funicular and 1 club segment; club with a patch of RS apicoventrally; A2 closely appressed to F1; funicular segments narrower than club; PLS absent on funicle, those on club attached to surface for almost entire length. Mandible with a socketed anterior tooth. Maxillary palp with 1 or rarely (*Vanlisus*) with an apparently small apical second segment. Fore wing moderately wide; venation sinuate with MV curving apically away from wing margin to form an elongate SV, PM and MV confluent, PM with 2 setae and 2 campaniform sensilla at apex; disk with most setae arranged in linear tracks, RS1 present. Hind wing having 2–3 setal tracks on disk, middle track reaching apex of wing, anterior and/or posterior tracks complete or not. Mesophragma not notched apically. Metasomal tergum I (petiolar) with a transverse row of erect, sharply pointed denticles.

*Male*. *Trichogramma* (*Trichogramma*): Antenna with only a single distinct postantennal segment - an elongate and usually slightly curved club segment with incomplete, obsolescent lines of internal division.

A1 present; A2 fused to base of club. Club with numerous exerted FS, PLS attached to antennal surface for most of their length, never spiniform. GC with a distinct, often elongate, DLA of varying shape; VS and PAR present, IVP usually present and well developed. *Trichogramma* (*Vanlisus*): Antenna with 2 funicular and 3 club segments; club compact, C3 subconical, pointed at apex, sensilla as in nominate subgenus. GC as in nominate subgenus except ADG apparently bilobed in New World species (Pinto 1992).

*Distribution*.—Cosmopolitan.

*Diversity*.—With 210 described species worldwide, *Trichogramma* is the largest genus of Trichogrammatidae. Of this total, 98 are from the New World (47 Nearctic, 35 Neotropical, 16 both regions). Three species belong to the uncommonly collected subgenus *Vanlisus*. The remainder are assigned to the nominate subgenus. The third subgenus, *Trichogrammanza*, occurs in Australia and New Zealand. Although relatively well studied compared to other genera, undescribed species remain in all parts of the world.

There has been considerable artificial movement of *Trichogramma* species for biological control. Although there are exceptions (e.g. Pinto et al. 1993), there is little evidence that most exotic species establish in areas of introduction (Pinto 1999).

*Discussion*.—The characteristic sinuate fore wing venation with an RS1 setal track and 2F/1C antennal formula in females separate *Trichogramma* from other genera. The genus is most similar to *Trichogrammatoidea*. Separation of the two is covered in more detail in the treatment of the latter. Other New World genera that may be confused include *Paratrachogramma* and *Trichogrammatomyia*. As in *Trichogramma* females of both have a single antennal club segment with a patch of recurved setae ventroapically; general body shape is similar as well. Both genera lack the distinctive sinuate venation of *Trichogramma*. *Trichogramma* has previously been characterized as the only trichogrammatid genus with a dorsal

lamina on the male genital capsule (Pinto 1999). However, as indicated, a similar structure also occurs in males of *Thanatogramma*.

*Trichogramma* is the best known genus in the family because of its use for inundative biological control of pest Lepidoptera (Smith 1996, Parra and Zucchi 2004). The New World species are divided into two subgenera, the nominate and *Vanlisus* (Pinto 1999). Their separation is provided in the key and in the diagnosis above. The third subgenus, *Trichogrammanza*, restricted to Australia and New Zealand, is separated by male antennal formula (2F/1C).

The North American species of *Trichogramma* were recently revised by Pinto (1999). The South American fauna has yet to be studied in detail. Important recent treatments of South American species include Zucchi and Monteiro (1997), and Querino and Zucchi (2003a, b, c).

*New World records*.—Because of the cosmopolitan distribution of this genus, distribution records are not included. In general, the nominate subgenus occurs virtually everywhere. *Vanlisus* is known from Central America, Venezuela, Brazil and Mexico. Details on species distributions can be found in Pinto (1999), and in Zucchi and Monteiro (1997).

*Hosts*.—*Trichogramma* species primarily are parasitoids of Lepidoptera but eggs of several other orders, Diptera, Hymenoptera (Symphyta) and Neuroptera in particular, are attacked as well. Pinto (1999) itemizes known hosts for the North American species, and Zucchi and Monteiro (1997) list hosts for those in South America.

### 13. *Trichogrammatella* Girault (Figs 21, 107, 208)

*Trichogrammatella* Girault 1911. Type species: *Trichogrammatella tristis* Girault, by original designation.

*Diagnosis*.—*Female*. Antenna with 2 anellar and 5 club segments; club relatively narrow, widest at C1 and C2; all segments

with PLS; pedicel transversely ridged, ridges usually crenulate. Maxillary palp 2 segmented. Midlobe of mesoscutum and scutellum each with 2 pair of elongate setae. Fore wing moderately wide, c. twice as long as wide; venation with PM disjunct from MV, MV positioned slightly but distinctly behind anterior margin of wing and diverging apically to form an elongate SV, SV length subequal to or greater than MV length, not deviating strongly from wing margin, slanted toward middle of apical wing margin; disk moderately densely setose with linear setal tracks including RS1 present. Fore tibia with short, thorn-like spines on dorsal surface.

*Male.* Club shorter, PLS present or absent on C1. GC apparently completely open dorsally, with PAR and VS present, IVP absent.

*Distribution.*—New World tropics.

*Diversity.*—Monotypic. *Trichogrammatella* is uncommon in collections. Limited material available signals at least a few undescribed species.

*Discussion.*—This genus is easily distinguished by the clearly five-segmented club in both sexes with C1 and C2 subequal in width, the transversely ridged and usually crenulate pedicel, the placement of the marginal vein behind the fore wing margin, and the elongate stigmal vein which diverges modestly from the marginal vein. *Trichogrammatella* is most similar to *Mirufens*. Both have similar fore wing venation, a transversely ridged pedicel, dorsally spinose fore tibiae, and two-segmented maxillary palp. Antennal formula separates them. *Mirufens* has a distinct funicle, and males are further distinguished by the four-segmented club. Although the transverse ridges on the pedicel of both genera are crenulate, they are not consistently so in *Trichogrammatella*.

*Records.*—**Bolivia.** **Brazil:** Rondonia. **Costa Rica.** **Ecuador.** **Guatemala.** **Panama.** **West Indies.**

*Hosts.* Hemiptera: Membracidae (Girault 1911b).

#### 14. *Trichogrammatoidea* Girault (Figs 36, 114, 220, 221)

*Trichogrammatoidea* Girault 1911. Type species: *Chaetostricha nana* Zehntner, by original designation. Nagaraja 1978 (partial revision).

*Diagnosis.*—*Female.* Antenna with 2 anelli, 2 funicular and 1 club segment; club with a patch of RS apicoventrally; funicular segments narrower than club; PLS absent on funicle, those on club attached to surface almost entire length. Mandible with a socketed anterior tooth. Maxillary palp 1 segmented. Midlobe of scutum and scutellum each with 2 pair of setae, anterior pair on scutellum much shorter than posterior pair. Mesophragma entire at apex, not notched. Fore wing moderately wide, 2.0–2.5× as long as wide, fringe setae 0.2–0.5× FWW; venation sinuate with MV curving apically away from wing margin to form an elongate SV, PM and MV confluent, PM with only 1 seta and 1 campaniform sensillum at apex; disk with most setae arranged in linear tracks, RS1 absent. Hind wing disk with an incomplete medial setal track only. Metasomal tergum 1 (petiolar) with a transverse row of erect, sharply pointed denticles.

*Male.* Antenna with 2 funicular and 3 club segments, club segments loosely joined, C3 rounded apically; most species with numerous exerted and elongate spiniform PLS on club and funicle. GC with PAR and VS present, IVP present or not but very short if present, without a DLA or sclerotized bridge of any kind dorsal to ADG.

*Distribution.*—Primarily distributed in the Southern Hemisphere and Asia with one uncommon species from Europe.

*Diversity.*—Twenty-five species are assigned to *Trichogrammatoidea*. The number occurring in the New World is unclear because of several introductions for biological control (Querino and Zucchi 2004). Of the ten species recorded only five are indigenous, all from South America and the West Indies. *Trichogrammatoidea bactrae* Nagaraja, was introduced recently into



southwestern North America from Australia (Hutchison et al. 1990); its establishment remains questionable.

The indigenous New World species include: *Trichogrammatoidea annulata* De Santis (Brazil), *T. bennetti* Nagaraja (Brazil), *T. brasiliensis* (Ashmead) (Brazil), *T. hypsipylae* Nagaraja (Trinidad and Tobago), and *T. signiphoroides* Brèthes (Argentina). Those introduced are *T. armigera* Manjunath, *T. bactrae*, *T. eldanae* Viggiani, *T. nana* (Zehntner), and *T. robusta* Nagaraja (Noyes 2001). It should be mentioned that *Trichogrammatoidea brasiliensis* was described as a *Trichogramma* and that all of the numerous papers in the *Trichogramma* biological control literature using this incorrect combination are misidentifications (Pinto 1997b).

**Discussion.**—*Trichogrammatoidea* is most likely confused with *Trichogramma*. Males can always be separated by genitalia. In *Trichogrammatoidea* the genital capsule lacks the dorsal lamina found in all *Trichogramma* (Fig. 218); instead, except perhaps for a membranous sheet, it is completely open dorsally and trough-like (Fig. 220). Males of virtually all species also are separated by antennal segmentation (two funicular and three club segments in *Trichogrammatoidea*; a single compound postanellar segment in *Trichogramma*). The only exceptions to this antennal difference are species of the uncommonly collected *Trichogramma* (*Vanlisus*) which have the same antennal segmentation as *Trichogrammatoidea* (Pinto 1999). Females and males potentially confused with *Vanlisus* are best separated by fore and hind wing traits (Pinto 1997b). In the fore wing of *Trichogrammatoidea* the RS1 is absent and the premarginal vein has only a single seta; also the hind wing has only a single linear setal track. In the *Trichogramma* fore wing an RS1 is present, the premarginal vein has two setae, and the hind wing has two or three setal tracks, although all but the middle track may be incomplete.

The review of *Trichogrammatoidea* and key to species by Nagaraja (1978) does not

include all of the species that were known to occur. Querino and Zucchi (2004) recently redescribed *T. annulata*, a relatively common South American species; they also presented a key to the Brazilian species.

**New World records.**—**Argentina:** Tucuman. **Brazil:** Bahia, Minas Gerais, Paraná, Rio Grande do Sol, São Paulo. **Chile:** Juan Fernandez Islands. **Colombia.** **Costa Rica.** **Ecuador.** **Guatemala.** **Venezuela.** **West Indies.**

**Hosts.**—Lepidoptera: recorded from eggs of several families (see Nagaraja 1978, De Santis 1981).

### 15. *Trichogrammatomyia* Girault (Figs 37, 38, 115, 222)

*Trichogrammatomyia* Girault 1916. Type species: *Trichogrammatomyia tortricis* Girault, by original designation.

**Diagnosis.**—Small, c. 0.3 mm in length, body shape moderately robust. **Female.** Antenna with 2 anelli, 2 funicular and 1 or (less commonly) 2 club segments; club with a patch of recurved setae along apicoventral surface; PLS on club only. Mandible without a socketed tooth. Maxillary palp 1 segmented. Midlobe of scutum and scutellum each with 2 pair of setae, anterior pair on scutellum distinctly shorter than posterior pair. Fore wing 2.0–2.5× as long as wide; fringe setae elongate, the longest c. 0.5× FWW; venation with MV abruptly ending apically, stigmal vein approximately perpendicular to MV, with a distinct constriction between stigma and MV, MV longer than PM, a very short postmarginal vein often apparent; disk moderately densely setose, linear setal tracks sometimes obsolescent in posterior half of wing, RS1 absent. Mesophragma notched apically. Metasomal tergum I (petiolar) with a transverse row of denticles.

**Male.** Antenna with 2 funicular and 3 club segments; with PLS on F2 and all club segments. GC small subquadrate, completely open dorsally, trough-like, basal margin indistinct, with VS and PAR present, the former extending considerably

beyond PAR, a poorly developed IVP present or not.

*Distribution.*—Primarily New World from SE Canada to Argentina; also recorded from the Oceanic Region. See Discussion.

*Diversity.*—Monotypic. At least two or three undescribed species occur in the New World.

*Discussion.*—Within the New World *Trichogrammatomyia* is most easily confused with *Thanatogramma*, *Trichogramma* and *Trichogrammatoidea*. In all, the female antenna has similar segmentation with a patch of recurved setae apicoventrally on the club. Males of *Thanatogramma*, *Trichogrammatoidea* and *Trichogramma* (*Vanilisus*) also have an antennal formula identical to males of *Trichogrammatomyia*. The latter is separated by fore wing, mandible and mesophragmal structure. In *Trichogrammatoidea* and *Trichogramma* the marginal vein gradually curves away from the wing margin to form the stigmal vein (sinuate venation) and there is no abrupt change in width between the two veins. In *Trichogrammatomyia*, the marginal vein ends abruptly, the stigmal vein is roughly perpendicular to it and is much narrower basally than the marginal vein; also its fore wing is considerably narrower and the marginal fringe considerably longer (Fig. 115). From *Thanatogramma*, which has roughly similar venation, it is separated by its narrower fore wing, considerably longer wing fringe and much smaller size. The absence of an anterior socketed mandibular tooth, its apically notched mesophragma (Fig. 193) and the absence of a dorsal lamina on the male genitalia further distinguishes *Trichogrammatomyia*.

*Trichogrammatomyia* is very similar to the Australasian *Australufens*. Body shape, antennal structure in both sexes, wing structure, and male genitalia are similar in both. The only difference I detect is that in *Australufens* the aedeagal apodemes in the male genitalia are basally convergent and apparently fused (as in Fig. 210), whereas

they are separated and subparallel their entire length in *Trichogrammatomyia*. The Australasian genus *Pseudogrammina*, a probable synonym of *Australufens*, is similar. Previous authors did not compare these genera presumably because the female of *Trichogrammatomyia* was characterized as having two club segments based on the condition found in *T. tortricis*, its type species, whereas only a single club segment characterizes *Australufens* (Doutt and Viggiani 1968). It now appears that *T. tortricis* is an exception. Females of undescribed *Trichogrammatomyia* either have a single club segment or only a partially divided club.

*Trichogrammatomyia* and *Australufens* are similar to *Thanatogramma* and the Australasian *Brachyia*. Antennal formula is comparable in all three. It should be noted that, of the four, only *Australufens* and *Brachyia* are characterized by basal fusion of the aedeagal apodemes. Also, at least one undescribed species of *Australufens* has a two-segmented maxillary palp, a characteristic of all *Brachyia*. Basally fused aedeagal apodemes also characterize *Paratrichogramma*.

*Trichogrammatomyia* is uncommonly collected. Except for the type series I have not seen specimens of *T. tortricis* in collections. The only other records for the species are those listed by Doutt and Viggiani (1968) (see below); all are from SE Canada and NE United States. The other collections reported below represent undescribed species. Unlike *T. tortricis* the females of these species have a single club segment and the second funicular segment is about as long as the first (it is considerably shorter in the type species).

In addition to the New World, *Trichogrammatomyia* also has been collected in the Oceanic Region. Nafus (1993) records the genus from Guam. I have seen single males from Bora Bora (French Polynesia) and from the Hawaiian Islands (Molokai). Because the aedeagal apodemes in these males do not fuse basally they are

not assigned to *Australufens*. However, I have not seen material studied by Nafus and cannot verify that identification. The record of the genus from New Zealand (Noyes and Valentine 1989) requires corroboration. The fore wing illustrated is not characteristic of *Trichogrammatomyia*.

*New World records.*—**Argentina:** Formosa, Misiones, Salta. **Brazil:** Pará. **Canada:** New Brunswick (Doutt and Viggiani 1968), Ontario. **Chile:** Region VII. **Colombia.** **Costa Rica.** **Ecuador.** **Mexico:** Baja California Sur, Michoacan, Chiapas. **United States:** Connecticut (Doutt and Viggiani 1968), Florida, New York (Doutt and Viggiani 1968). **Venezuela.** **West Indies.**

*Hosts.*—Lepidoptera: Tortricidae (Girault 1916c).

#### 16. *Viggianiella* Pinto, new genus (Figs 39, 97, 98, 116)

*Type species.*—*Viggianiella tropica* Pinto, n. sp.

*Description.*—*Female.* Antenna with 1 anellus, 2 funicular segments and a single club segment. Funicular segments transverse; club without a patch of RS on ventral surface. Mandible without a socketed anterior tooth. Maxillary palp very short, possibly 2 segmented. Midlobe of mesoscutum and scutellum each with 2 pair of elongate setae. Propodeum distinctly longer than metanotum, posterior margin strongly undulate, disk lobiform. Wings unique: fore wing elliptical, relatively narrow, widest at middle, fringe setae as long or longer than FWW; disk glabrous; venation entirely confluent, strongly sinuate, SV extremely elongate, digitiform, unique in being directed anteroapically and extending apically considerably beyond apex of MV. Hind wing narrow, disk glabrous, with anterior and posterior fringe setae both extremely long. Mesophragma notched apically. Metasomal tergum I sclerotized, without a transverse row of denticles, anterior margin undulate, mirroring posterior margin of propodeum, together delimiting a 'dumbbell-shaped'

membranous area between the two terga (Fig. 97).

*Male.*—Unknown.

*Etymology.*—After Professor Gennaro Viggiani (University of Naples, Portici), in recognition of his major contributions to our knowledge of the Trichogrammatidae; gender feminine.

*Distribution.*—South America.

*Diversity.*—Monotypic.

*Discussion.*—Antennal formula coupled with characteristics of the wings separate this genus from all others in the family. Fore and hind wing structure in *Viggianiella* is unique and on this basis the genus is not easily compared to others. Fore wing venation with its elongate, anteroapically directed stigmal vein and the extremely elongate anterior fringe on the hind wings have no counterparts in the Trichogrammatidae.

Because males are unknown, the placement of *Viggianiella* in Trichogrammatinae is tentative and based solely on female antennal formula and structure. Antennae characterized by two relatively small funicular segments without PLS and one club segment, occur in females of several trichogrammatine genera. Included are *Apseudogramma*, *Australufens*, *Pseudogrammina*, *Trichogrammatomyia*, *Trichogramma* and *Trichogrammatoida*. The antenna of *Viggianiella* differs in that the ventral surface of the club lacks a patch of recurved sensilla, although what are presumably two elongate RS occur apically.

*Records.*—**Brazil:** Bahia. **Colombia.** (See below for specific localities).

*Hosts.*—Unknown.

#### *Viggianiella tropica* Pinto, new species

*Description.*—Based on 2 slide-mounted females. Except for body length, quantitative data taken from holotype; if variable in the two specimens data reported as a range.

*Female.* Body length c. 0.5 mm (N=1). Color apparently uniformly light brown;



fore wing moderately fumate except clear at apical fifth, anterior to SV, and at base behind SC, the latter area with a poorly defined longitudinal dark stripe running to base of wing. Toruli placed low on head, at level of ventral margin of eyes. Antenna with scape relatively narrow, slightly wider in basal half; pedicel bead shaped, c. half the length of scape; funicular segments transverse, F1 considerably narrower and shorter than F2; 1-segmented club subequal in length to scape, widest at base, gradually narrowing to apex; length/width of scape, pedicel, funicular segments and club: 42/12, 22/18, 6/11, 12/15, 42/16. Antennal sensilla: anellus and F1 each with 1 APB, F2 – 2 APB, c. 3 APA and 1 PLS; club – row of several APA at base, with several FS (the longest c.  $2.5\times$  greatest club width), at least 5 PLS (3 of these extending off surface of club for 0.3–0.5 their length), 2 very long RS? at apex extending considerably beyond apex of club; BPS absent or not visible. Maxillary palp present but very short, possibly 2 segmented. Mandible with 3 teeth, 2 of these strong, distinct. Pronotum relatively long, narrowly divided longitudinally at midline. Midlobe of mesoscutum with both pair of setae in basal half, the two pair of scutellar setae adjacent to posterior border; surface of midlobe and scutellum very smooth, relatively large obsolescent reticulae visible on midlobe only; a median sulcus on scutellum and basally on midlobe. Mesophragma elongate, c.  $1.75\times$  HTL. Fore wing  $3.8\times$  as long as wide, widest near middle of wing, venation attaining 0.85 FWL, fringe length 1.3–1.4 $\times$  FWW; venation narrow, strongly sinuate, confluent; relative length of PM, MV and SV = 3 : 8 : 5; MV curving basally to meet PM, widest at apex, with 3 elongate anterior setae; PM with 2 setae and 2 campaniform sensilla at apex; SV without a distinct stigma, narrowest at basal half, only slightly widening in apical half; disk glabrous except 1 short seta behind SC and anterior to stigma (these setae seen

only in the female from Colombia). Hind wing with elongate anterior fringe setae c.  $0.8\times$  the length of posterior fringe setae, their length 0.7 and 0.9 the distance from hamuli to wing apex, respectively (all measurements possible only in Colombian specimen). Midfemur with apical spine elongate, robust, c. half length of femur; spines at apex of fore and hind femora considerably shorter; tarsomeres of midleg elongate, with segment I distinctly longer than II or III; tarsomeres of fore and hind legs shorter, subequal. Ovipositor not extending beyond apex of metasoma, length  $2.0\times$  HTL, with gonangulum posterior to base of ovipositor itself, gonoplac very short, outer plate gradually but distinctly narrowing to apex.

*Male*.—Unknown.

*Type*.—Holotype ♀, BRAZIL. *Bahia*: Mucuri; xi-78; F. Benton; in BMNH.

*Distribution*.—Known only from eastern Brazil and Colombia.

*Material examined*.—2 ♀. BRAZIL. *Bahia*; 1♀ (see Type). COLOMBIA. *Amazonas*: PNN Amacayacu, Matamata (150 m); 03 23' S, 70 06' W; Malaise trap (M682); 1♀; A. Parente; UCRC.

*Comments*.—The two females available are not ideal for observing all important features. For example, the maxillary palp, visible only in the holotype, is very short and it is not clear if one or two segments are present. What appears to be a small second segment may actually be the base of the apical sensillum. Similarly, basiconic peg sensilla (BPS) are not clearly visible on the antenna; yet these sensilla occur in all other trichogrammatids. Both specimens studied show what may be a single very elongate BPS at the middle of the club but this must be confirmed.

### 17. *Xenufens* Girault (Figs 40–42, 117, 223)

*Xenufens* Girault 1916. Type species: *Xenufens ruskini* Girault, by original designation.

*Pseudoxenufens* Yoshimoto 1976. Type species: *Pseudoxenufens forsythi* Yoshimoto, by original designation. **New synonymy.**

*Diagnosis.*—*Female.* Antenna short, compact, with 1 anellus, 2 funicular and 2 complete club segments; terminal club segment partially divided or not, without a patch of RS; funicular segments transverse, distinct or partially fused; surface dominated by APA, without FS. Maxillary palp 1 segmented. Mandible with a large socketed anterior tooth. Midlobe of mesoscutum and scutellum each with 2 pair of strong setae. Fore wing wide, c.  $2\times$  as long as wide; venation somewhat sinuate with MV placed slightly behind anterior margin of wing, curved and narrowing apically to form SV, SV with a distinct stigma apically; disk moderately densely setose with linear setal tracks present including RS1. Mesophragma not notched apically. Metasomal tergum I (petiolar) with a transverse row of denticles.

*Male.* Antenna with funicular segments slightly more elongate than in female, not partially fused; FS present on both funicular and club segments; club completely 2 segmented (in *ruskini*). GC completely open dorsally, trough-like, divided apically into 2 lobes (fused PAR and VS?).

*Distribution.*—Known almost exclusively from the New World, from SE United States S to Argentina, with single records from Papua New Guinea and Indonesia.

*Diversity.*—There are two species of *Xenufens*. *X. ruskini* is widespread, occurring throughout the range of the genus; *X. forsythi*, **new combination** (from *Pseudoxenufens*) is known from Ecuador, Colombia and Costa Rica. Single females from New Guinea and Indonesia in UCRC are indistinguishable from *X. ruskini*.

*Discussion.*—The two-segmented, highly transverse funicular segments and two/three-segmented club, the nearly sinuate fore wing venation, and placement of the marginal vein slightly behind the anterior wing margin separate *Xenufens* from all other trichogrammatids. The genus is most similar to *Trichogramma*, *Trichogrammatoidea* and *Trichogrammatomyia*. Females of all three have similar antennal structure, but

unlike *Xenufens* the club usually is one segmented in these genera and bears a patch of RS ventrally. *Trichogramma* and *Trichogrammatoidea* also have sinuate fore wing venation although the MV coincides with the wing's anterior margin.

*Pseudoxenufens* is treated as a synonym of *Xenufens*. Yoshimoto (1976) separated the two primarily by the number of funicular segments in the female and apparently by the placement of the marginal vein slightly behind the anterior margin of the fore wing. The two are similar in both respects, however. The marginal vein is similarly positioned, although perhaps it is slightly more posterior in the type species of *Pseudoxenufens*. SEM examination of the funicle of the type species of both show that it is only the relative length of the funicular segments that differ. In *X. ruskini*, F1 is longer than F2 and both segments are distinct (Fig. 40). In *X. forsythi*, F1 is extremely short, disciform, partially fused to F2 and visible only in medial view (Figs 41, 42). One can question whether what is being called F1 represents a funicular or an anellar segment since neither F1 nor F2 bear BPS, a feature often characterizing funicular segments in this family. However, the coeloconic sensillum generally associated with A2 does not occur on the putative F1 of *X. forsythi* (Fig. 42), suggesting that it is a true funicular segment, homologous to F1 in *X. ruskini*. Also, BPS are lacking on the funicular segments of both species. In addition, structural similarity in the two species suggests homology. In both, F2 is ringed with APA positioned slightly behind the apex of the segment, and F1 appears to lack marginal setae or sensilla of any kind (cf. Figs 40, 42). It is possible that A2 has merged with F1 in both species. Yoshimoto also notes that the number of club segments differs in females of *Pseudoxenufens*. The difference is minimal (two in *forseythi*, two with an incomplete third in *ruskini*); overall club structure is similar in both.

Males of *Xenufens ruskini* are virtually unknown. Of the 160 specimens of this species in the UCRC only one male is represented. Males may be more common in *X. forsythii*; its type series consisted of five males and 46 females (Yoshimoto 1976). The discovery of the single male of *X. ruskini* provides additional evidence for the proposed generic synonymy. In both species the genital capsule is divided apically into two lobes, a unique feature in the family [cf. Fig. 223, and Fig. III (4) in Viggiani 1984].

*New World records.*—**Argentina:** Missiones. **Belize.** **Brazil:** Minas Gerais, Rondonia. **Colombia.** **Costa Rica.** **Ecuador.** **Guatemala.** **Mexico:** Jalisco, Tamaulipas, Veracruz. **Panama.** **Peru.** **United States:** Florida. **West Indies.**

*Hosts.*—Lepidoptera: Nymphalidae (Malo 1961, Yoshimoto 1976), Hesperiididae (Girault 1916a; Pinto, unpubl.). *Xenufens* has been reported as phoretic on adults of its host. *X. forsythii* was taken from eggs and adults of *Caligo eurilochus* (Cramer) (Malo 1961) and I have examined a series of *X. ruskini* collected in Jalisco by A. Warren labeled 'ex. thorax of Hesperiididae butterflies'.

Oligositinae

*Diagnosis.*—Maxillary palp 1 segmented. *Male.* Type 2 genitalia: GC and ADG consolidated into a single structure and not distinguishable, at least not in apical half of genitalia; ADG presumably not capable of movement independently of GC, AAP of ADG present or not in basal half; GC with VS and PAR present or absent. Figs 224–259.

*Discussion.*—As indicated above, the definition of subfamilies adopted here transfers to the Oligositinae the Paracentrobiini as well as certain genera previously placed in the Trichogrammatini. This hypothesizes a monophyletic Oligositinae based on the consolidation of aedeagus and genital capsule.

Paracentrobiini Howard

*Diagnosis.*—Antenna (Figs 43–45) with 2 funicle and 2 or 3 club segments; F2 much shorter than F1; PLS absent from funicular segments in New World genera. Eyes reddish. Midlobe of mesoscutum and scutellum each with two pair of setae. *Male.* Last visible sternum modified into a shelf-like structure, or with a pair of platform or narrow and elongate appendages (Figs 224–226). Type 2A genitalia: GC subconical, bearing ventral setae, ADA short, transverse, open dorsally; aedeagal AAP present (Figs 224–226).

*Discussion.*—The Paracentrobiini include four genera, *Paracentrobia*, *Ittys*, *Ittysella*, and *Paraittys*. All but *Paraittys* occur in the New World. Antennal structure and the metasomal sternal modifications in males separate paracentrobiines from all other New World trichogrammatids. These features are derived and the tribe is hypothesized as monophyletic. The treatment of genera below borrows from a thesis by J. George at UCRC (George 2003).

18. *Ittys* Girault  
(Figs 44, 119, 225)

*Ittys* Girault 1911. Type species: *Trichogramma ceresarum* Ashmead, by original designation. Douth and Viggiani 1968 (as subgenus of *Paracentrobia*). Viggiani 1971 (renewed generic status).

*Diagnosis.*—*Female.* Antenna with 2 anelli, 2 funicular and 3 club segments; F1 longer than wide, usually cylindrical, F2 about as wide as long, not transverse; club segments longer than wide, distinct, never partially fused. Fore wing c. twice as long as wide, fringe setae short, c. 0.2× FWW; venation with SV relatively long, with a distinct constriction between stigma and MV; disk moderately densely setose with distinct linear setal tracks, RS1 present, consisting of several setae.

*Male.* GC with VS sickle shaped at apex; length of ADA less than 1/3 GL; last



visible sternum with subcircular or subtriangular, platform appendages, each bearing a terminal spine.

*Distribution*.—Recorded from all regions of the world.

*Diversity*.—There currently are six named species of *Ittys*. Three occur in the New World: *I. cerasarum* (Ashmead), *I. nymphea* (Girault), and *I. prima* Perkins. The North American species are undergoing revision by J. George (UCRC) and current species concepts will be revised considerably.

*Discussion*.—*Ittys* is separated from the other New World paracentrobiine genera by the cylindrical, longer than wide F1 and non-transverse F2, the RS1 setal track in the fore wing, and the paired, relatively wide, platform appendages on the last metasomal sternum in males.

*New World records*.—**Brazil**: Minas Gerais. **Costa Rica**. **Guatemala**. **Mexico**: Campeche, Chiapas, Michoacan, Nuevo Leon, San Luis Potosí, Sinaloa, Tamaulipas, Veracruz. Yucatan. **United States**: Arizona, California, Colorado, Florida, Georgia, New Mexico, Texas, Indiana, Illinois, Kansas, Oregon, Mississippi, Missouri, South Carolina, Tennessee, Utah, Virginia, Washington, Wisconsin, West Virginia. **West Indies**.

*Hosts*.—Hemiptera: Auchenorrhyncha and Heteroptera (George 2003, Tipping et al. 2005).

#### 19. *Ittysella* Pinto and Viggiani (Figs 45, 120, 226)

*Ittysella* Pinto and Viggiani 1987. Type species: *Ittysella lagunera* Pinto and Viggiani, by original designation.

*Diagnosis*.—*Female*. Antenna with 1 anellus, 2 funicular and 2 complete club segments, if club apparently with 3 then C1 and C2 partially fused, F1 wider than long, F2 short, transverse. Fore wing relatively narrow, 2.5× as long as wide, fringe setae elongate, c. 0.5× FWW; venation with SV short and broad, with only a slight constriction at base of stigma; disk

sparsely setose, with few linear setal tracks, RS1 absent or consisting of 1–3 staggered setae.

*Male*. GC with VS sickle shaped at apex, ADA length a third or more GL; last metasomal sternal modification consisting of a single rectangular, shelf-like structure (not paired as in other paracentrobiine genera).

*Distribution*.—Southwestern North America.

*Diversity*.—Only the type species, *I. lagunera*, currently is assigned to *Ittysella*. However, additional species are known and will soon be described by J. George (UCRC).

*Discussion*.—*Ittysella* differs from other paracentrobiines by the single anellar segment, and the partial or complete fusion of C1 and C2 (cf. Figs 43–45). It is further separated from *Ittys* by the narrower fore wing and its longer fringe, the poorly developed or absent RS1, the wider than long F1 and F2, and the undivided, shelf-like modification of the last sternum in males. Fore wing and funicular structure is more similar in *Paracentrobia*. Unlike *Ittysella*, however, in *Paracentrobia* the antennal club is three segmented, the male genitalia lack distinct volsellae, and the modifications of the last metasomal sternum are paired and elongate (cf. Figs 224, 226).

*New World records*.—**Mexico**: Baja California Sur, Coahuila, Sonora. **United States**: Arizona, California, New Mexico, Oregon, Texas, Utah.

*Hosts*.—Hemiptera: Cicadellidae (Pinto and Viggiani 1987).

#### 20. *Paracentrobia* Howard (Figs 43, 118, 224)

*Paracentrobia* Howard 1897. Type species: *Paracentrobia punctata* Howard, by monotypy.

*Abbella* Girault 1911. Type species: *Abbella subflava* Girault, by original designation. Doutt and Viggiani 1968 (synonymy).

*Brachistella* Girault 1911. Type species: *Trichogramma acuminatum* Ashmead, by original designation. Doutt and Viggiani 1968 (synonymy, treatment as subgenus).

*Jassidophthora* Perkins 1912. Type species: *Jassidophthora prima* Perkins, by monotypy. Doutt and Viggiani 1968 (synonymy).  
*Abbellisca* Ghesquière 1946 (unjustified *n. n.* for *Abbella*).

**Diagnosis.**—*Female*. Antenna with 2 anelli, 2 funicular and 3 club segments, C1 and C2 not partially fused; funicular and club segments wider than long. Fore wing relatively narrow,  $2.3\text{--}2.6\times$  as long as wide, fringe setae c.  $0.2\times$  FWW; disk moderately densely setose, with or without distinct setal tracks, RS1 usually absent.

*Male*. GC without distinct, sickle-shaped VS; paired appendages of last metasomal sternum elongate, strap shaped.

**Distribution.**—Worldwide.

**Diversity.**—Forty-three species are assigned to *Paracentrobia*, although several of these may not be correctly placed. Eight nominal species occur in the New World (George 2003). The genus occurs throughout the area but none have been described from South America.

**Discussion.**—*Paracentrobia* is separated from both *Ittysella* and *Ittys* by male features. The genitalia of the latter two possess sickle shaped volsellae (Figs 225, 226). In *Paracentrobia* volsellae are present but vestigial and consist of obsolescent lobes on the ventral surface; they can be seen under the SEM but not easily with light microscopy (Fig. 224). Male *Paracentrobia* also are identifiable by the elongate, strap-like appendages on the last metasomal sternum. Both sexes are separated by antennal structure. *Paracentrobia*, unlike *Ittysella*, has two anelli and three complete club segments. The wider than long funicular segments provides separation from *Ittys* (cf. Figs 43, 44).

Doutt and Viggiani (1968) originally treated *Ittys* and *Brachystella* as subgenera of *Paracentrobia*. Viggiani (1971) later returned *Ittys* to generic status. Although *Brachystella* remains a valid subgenus, it never has been clearly distinguished from the nominate group and its status is questionable. In general, species assigned

to *Brachystella* have a fore wing which is narrower and with more dense setae which are not distinctly arranged into linear tracks.

**New World records.**—**Argentina:** Formosa, Jujuy, La Rioja, Misiones, Salta. **Bermuda.** **Belize.** **Bolivia.** **Brazil:** Goiás, Minas Gerais, São Paulo. **Canada:** Alberta, British Columbia, Manitoba, New Brunswick, Ontario, Prince Edward Island. **Costa Rica.** **Colombia.** **Ecuador.** **Honduras.** **United States:** Arizona, California, Colorado, Georgia, Florida, Illinois, Indiana, Iowa, Kansas, Maryland, Mississippi, Missouri, Montana, Nebraska, New Mexico, Nevada, North Carolina, Oklahoma, Oregon, Pennsylvania, South Carolina, Texas, Utah, Virginia, Washington, Wisconsin, Wyoming. **Peru.** **Venezuela.** **West Indies.**

**Hosts.**—Hemiptera: Auchenorrhyncha (primarily) and Heteroptera (George 2003). Also recorded from Lepidoptera (Polaszek et al. 1998) but this needs confirmation.

### Chaetostrichini Walker

**Diagnosis.**—Antennal segmentation variable but funicle, if present and 2 segmented, with F2 subequal to or longer than F1; PLS present or not on funicle. Eyes reddish. Scutellum always with at least 2 pair of setae; midlobe of mesoscutum usually with 2 pair. *Male*. Last visible metasomal sternum not modified as in paracentrobiines (Figs 260, 261). Type 2A genitalia: GC with or without ventral setae, ADA relatively large and open dorsally, aedeagal AAP present or not (Figs 227–257).

**Discussion.**—The definition of the Chaetostrichini adopted here represents all Oligositinae without the synapomorphies of the Paracentrobiini and Oligositini. As such it clearly is not monophyletic. Tribal limits are similar to those originally proposed by Viggiani (1971). The only exception is the inclusion of certain genera with Type 2A genitalia that Viggiani originally placed in the Trichogrammatini

because of the presence of aedeagal apodemes.

Twenty-seven New World genera are placed here. At least two assemblages within the tribe are hypothesized as monophyletic. One includes *Burksiella*, *Centrobiopsis*, *Chaetostricha*, *Lathromeroidea*, *Uscanoidea*, *Zaga*, and *Zagella* (= *Chaetostricha* group). This group is characterized as follows: first postanellar segment (F1 or C1) very short, transverse, considerably shorter than and closely appressed to second (F2 or C2); club three (rarely two) segmented; fore wing with distinct setal tracks including RS1; stigmal vein well developed. Molecular evidence also supports monophyly (Owen et al., in press). The limits of these genera are not clear-cut and several species cannot be placed easily. The assemblage is extremely speciose in the New World, especially in the tropics, with the vast majority of species undescribed. Intermediate forms suggest that current generic definitions will require revision once species-level taxonomy is better understood.

Another generic grouping includes *Brachygrammatella*, *Chaetogramma*, and *Xiphogramma* (= *Brachygrammatella* group). Characteristics include the following: antennal funicle partially or completely divided into two subequal segments; club one or obsolescently two segmented and with numerous short, fine APB sensilla; fore wing with stigmal vein short and lacking a basal constriction, disk densely setose with linear setal tracks absent or few in number (RS1 absent). Generic limits in this assemblage also remain confused. This problem, discussed by Pinto (1990b), is summarized here in the treatment of *Chaetogramma*.

The affinity of the other genera in this tribe are not clear. Phenetic similarities which pose problems for identification and certain suggested relationships are discussed in the treatments of individual genera. The molecular study by Owen et al. (in prep.) also considers their relationships in greater detail.

## 21. *Adelogramma* Pinto, new genus (Figs 63–66, 139, 241)

*Type species*.—*Adelogramma primum* Pinto, n. sp.

*Description*.—Body small (< 0.5 mm in length), compact, somewhat gibbose; eyes very dark red, approaching black in color. Antenna strongly sexually dimorphic. *Female*. Antenna long compared to body length (c. half body length in most species), with 1 anellar segment; funicle absent; club asymmetrically tapering from base to apex, ventral surface broadly convex, dorsal surface straight or slightly concave, club segmentation obsolescent with 3 completely separated segments (C1–C3), separation of C3 and C4 complete only over half antennal circumference, separation of C4 and C5 even less complete, all sutures faint; C1 extremely short, anelliform; C2 transverse, much wider than long; partial separation of C3 and C4 near base of combined segment; club with PLS on C2 free for c. half its length and, in most species, with at least one spiniform PLS (entirely free of segment except at base) and a large patch of elongate RS ventroapically on C3/4/5. Maxillary palp 1 segmented, with a setiform rather than a peg-like sensillum near apex. Midlobe of mesoscutum and scutellum each with 2 pair of elongate setae. Fore wing c. 2× as long as wide, fringe setae elongate, 1/3 or more FWW; disk moderately densely setose with distinct setal tracks, RS1 present, with a small patch of foliate sensilla on ventral surface anterior to retinaculum; venation with PM disjunct and narrower than MV, MV considerably longer, SV distinct. Hind wing with anterior fringe confined to apical third or fourth of wing. Ovipositor short, length not exceeding HTL and not extending beyond apex of metasoma.

*Male*. Antenna distinctive: club suboval with 5 segments; C1 very short as in female, C4 incompletely sclerotized on all surfaces; C3, C4, C5 each with extremely



elongate, thick spiniform PLS, their length exceeding length of club itself. Genitalia simple, tubular, with an elongate ADA; AAP, PAR, VS and ventral setae absent.

*Etymology*.—From ‘adelos’ (Gr.), something imperceptible or secret; ‘gramma’ (Gr.), common ending for trichogrammatid genera signifying ‘lines’ ‘that which is drawn’, etc.; gender neuter.

*Distribution*.—Eastern United States, Central and South America.

*Diversity*.—There are at least four species of *Adelogramma*. One occurs in the United States; the others are distributed in Central and South America. Only the U.S. species, *A. primum*, is described below.

*Discussion*.—Antennal structure separates *Adelogramma* from other genera. As in certain genera of the *Chaetostricha* group the antenna lacks a funicle and the club has a very short, anelliform first segment. However, unlike these genera, females of *Adelogramma* have an asymmetrical club with only three complete segments; also the club usually has at least one spiniform PLS and another which extends beyond the antennal surface for about half its length. The antennal club in males is unique among New World genera. Although five segmented, it bears several spiniform PLS which are much longer than the club itself. The antenna of the male of the monotypic New Zealand genus *Zelogramma* described by Noyes and Valentine (1989) bears remarkable resemblance to that of *Adelogramma*. Genitalic structure, however, clearly places *Zelogramma* in the Trichogrammatinae.

*Adelogramma* perhaps is most similar to *Adryas*. In both the antennal club is incompletely five segmented in females but with five distinct segments in males. However, in *Adryas* the PLS are never spiniform in males or females, the PM is distinctly wider than the MV and confluent with that vein, and the hind wing anterior fringe extends most of the distance beyond the hamuli. Eye color also differs (bright red in *Adryas*, very dark red in *Adelogramma*).

*Records*.—**Colombia. Costa Rica. Ecuador. United States:** (see description of *A. primum* for detailed records).

*Hosts*.—Unknown.

*Adelogramma primum* Pinto, new species

*Description*.—*Female*. Small, body length 0.3 mm; color entirely light brown with antennae and legs somewhat lighter (based on two card-mounted specimens). Fore wing lightly fumate behind venation. Mandible with 3 strong, sharply pointed teeth posteriorly and 1 shorter, less sclerotized anterior tooth. Maxillary palp c. 3× as long as wide, narrowing asymmetrically to apex; terminal seta very long, c. 1.8× length of palp. Length/width of scape, pedicel and club: 36/10, 18/13, 50/20. Club with a short terminal process, widest near apex of C2, with 3 complete segments: C1 very short, anelliform, C2 transverse, c. 0.4× as long as wide; sutures between C3 and C4 apparent on medial surface only, a faint indication of a less complete C4–C5 suture also visible medially, all sutures obsolescent; consolidated C3/4/5 segment 5× length of C2. Club sensilla: C1 with 2 BPS; C2 with several APA, 1 elongate APB and 1 curved PLS extending beyond surface for c. half its length; C3/4/5 with several APA ventrally in basal half, BPS present adjacent to partial segment sutures and at apex of C5, c. 7 PLS (3 of these spiniform, attached only at base, others with apical 1/3 or so extending beyond surface), 1 APB on dorsal surface near apex, a setiform UPP inserted at apex of short terminal process; all BPS large, subglobose.

Midlobe of mesoscutum and scutellum each with 2 pair of elongate setae, anterior pair on midlobe longer than posterior pair, scutellar setae subequal in length; dorsum of midlobe reticulate with irregularly shaped (primarily subquadrate or subrhomboid) cells which are widest anteriorly and laterally, becoming more linear and much narrower at middle, scutellar sculpturing composed entirely of relatively

narrow, linear cells; cells on midlobe weakly corrugated within. Propodeal disk only slightly produced posteriorly, rounded, c.  $2\times$  length of metanotum. Fore wing  $2\times$  as long as wide, venation attaining 0.5 FWL, fringe setae  $0.3\times$  FWW; venation with MV very long, straight,  $1.8\times$  length of PM, with 3 elongate anterior setae and 5 shorter posterior setae dorsally; PM narrower, linear, angling slightly posteriorly, with 2 elongate setae and 2 campaniform sensilla at apex; SV well indicated, c.  $1/3$  the length of MV, arising at about a right angle from posterior corner at apex of MV, with a narrow constriction between suboval stigma and MV; radial process absent. Fore wing disk moderately densely setose with most setae arranged in linear tracks; RS1 straight, angling posteriorly from stigma; 2 basal track setae; narrow costal cell with 2 setae at anterior margin; 3–4 foliate sensilla on ventral surface anterior to retinaculum. Hind wing narrow, with 2 complete setal tracks anteriorly and an incomplete posterior track (extending 0.6 distance from hamuli to wing apex in holotype but shorter in most other specimens). Ovipositor short,  $OL/HTL = 0.80$  ( $N=4$ ).

*Male.* Antenna very different from that of female. Club suboval, symmetrical, shorter (only c. 0.9 length of scape), distinctly 5 segmented; C1 as in female (anelliform); C2, C3 and C4 transverse; C2 and C3 subequal in length; C4 shorter; C5 almost twice length of C4, broadly subconical. Club sensilla: C2–C4 each with an extremely elongate, thick spiniform PLS, C5 with 2 elongate PLS; PLS length c.  $1.75\times$  that of entire club; RS absent; only 1 FS visible (on C4); 1 APB on C2 and a few APA on C2 and C3. GC short, its length c.  $0.5\times$  HTL; ADA occupying c. 0.5 GL.

*Types.*—Holotype ♀ and allotype ♂: UNITED STATES. *South Carolina*: Dorchester Co., Harleyville, 10 km NE (Francis Beidler For.); bald cypress swamp; MT/FIT; vi-11/23-1987; in CNC. One additional female designated as paratype (data same except 'nr. Harleyville, x-1/10-1987; MT; BRC Hym. Team'), in UCRC.

*Etymology.*—'Primum' (L.), the first (*Adeogramma* to be described).

*Distribution.*—Southeastern United States.

*Material examined.*—14♀, 1♂ (all except 2♀ on slides). UNITED STATES. *Florida*: Fat Deer Key (Monroe Co.); viii-31/xii-15-1986; MT/FIT; 1♀; S./J. Peck.

*Missouri*: Williamsville; vii-16/viii-8-1988, ix-1/20-1988; MT; 2♀; J. Becker. *Louisiana*: Chicot State Park (Evangeline Parish); vii-15/21-1971; 1♀; G. Heinrich. *Maryland*: Prince Frederick, 7 km S (hardwood forest); ix-24/xi-14-1987; MT; 1♀; BRC Hym. Team. *Oklahoma*: Red Oak (Latimer Co.); ix-1993; FIT; 1♀; K. Stephan. *South Carolina*: Harleyville, 10 km NE, [and] Harleyville, nr.; 2♀, 1♂; (see Types). Pendleton (225 m); vi-24/vii-1-1987, viii-6/14-1987, ix-5/9-1987; MT; 5♀; BRC Hym. Team. Pendleton, Tanglewood Spring,  $34^{\circ} 38.7' N$ ,  $82^{\circ} 47.1' W$  (225 m); ix-15/30-1987; MT; 1♀; J. Morse.

*Comments.*—There are an additional three or four closely related species occurring in Central and South America. *A. primum* females is separated by the following combination of traits: midlobe of mesoscutum with suboval to subrhomboidal reticulations laterally with cells weakly corrugated within; mandibular teeth regular in shape; antennal club with subglobose BPS and spiniform PLS. In the undescribed species, the mesoscutum either is linearly reticulate, or with cells which are smooth within. In at least one species one of the posterior mandibular teeth is apically bifurcate. In at least two of the undescribed species the BPS are narrow and subfusiform in shape. Finally, in a species from Costa Rica the female lacks spiniform PLS. Males are available for more than one of the undescribed species; all have the same antennal dimorphism indicated for *A. primum*.

## 22. *Adryas* Pinto and Owen (Figs 67, 68, 140, 141)

*Adryas* Pinto and Owen 2004. Type species: *Adryas magister* Pinto and Owen, by original designation.

**Diagnosis.**—*Female.* Antenna with 1 anellus, and 3–5 club segments but club with segments variously fused, in total or in part, and never with 5 completely separated segments, last segment of club with at least a few RS ventroapically; C1 anelliform, very closely appressed to C2. Fore wing variable but with following characteristics: venation elongate, attaining 0.6–0.8 FWL, MV and PM confluent, PM triangular, widest at base, distinctly wider than MV, deviating minimally if at all from wing margin, with a distinct gap between SC and PM; disk fumate behind venation, with linear setal tracks apical to fumate area, RS1 present or not.

*Male.* Antennal club completely 5 segmented and without RS in species whose males are known. GC lacking PAR and VS, ventral setae present; aedeagal AAP absent.

**Distribution.**—Central and South American tropics.

**Diversity.**—*Adryas*, with eight species, was recently described (Pinto and Owen 2004); none of its species had been known previously. Included are *A. albicerata*, *A. bochica*, *A. erwini*, *A. incompta*, *A. iris*, *A. lioptera*, *A. magister* and *A. plurifumosa*. Although the genus is widespread in the American tropics with relatively high levels of sympatry, representatives are not commonly collected. A key to species is provided by Pinto and Owen (2004).

**Discussion.**—*Adryas* is distinguished by antennal formula and wing venation. The anelliform C1, incompletely separated club segments in females, and the shape and position of the premarginal vein are distinctive. *Uscanoidea* and *Zaga*, also with a five-segmented club and similarly anelliform C1 are separated by wing venation characterized by the premarginal which is narrower or subequal in width to the marginal vein, never wider. The fumate fore wing and presence of recurved setae on the club further separate *Adryas* from these genera. *Uscanopsis* which also may be

confused with *Adryas* does have a relatively wide premarginal vein. However, the shape of this vein is not comparable (elongate and widest at the middle, not subtriangular and widest basally as in *Adryas*). The elongate apical spur of the hind tibia in *Uscanopsis* (c. 0.9 the length of entire hind tarsus) is a further distinguishing trait.

**Records.**—**Belize. Bolivia. Colombia. Costa Rica. Ecuador. Peru. Venezuela.** See Pinto and Owen (2004) for detailed collection records of all eight species.

**Hosts.**—Unknown.

23. *Aphelinoidea* Girault

(Figs 46, 121–123, 163, 175, 227, 228)

The synonymy below follows Doult and Viggiani 1968.

*Aphelinoidea* Girault 1911. Type species: *Aphelinoidea semifuscipennis* Girault, by original designation.

*Lathromeroides* Girault 1913. Type species: *Lathromeroides longicarpus* Girault, by original designation. Currently as subgenus.

*Diaclava* Blood and Kryger 1928. Type species: *Diaclava waterhousei* Blood and Kryger, by original designation. Currently as subgenus.

*Krygeriola* Nowicki 1934. Type species: *Krygeriola dolichoptera* Nowicki, by original designation. Originally as subgenus of *Aphelinoidea*; currently synonym of *Lathromeroides*.

*Thalesanna* Girault 1938. Type species: *Aphelinoidea nigrioculae* Girault, by original designation. Currently as subgenus.

*Lengerkeniola* Nowicki 1946. Type species: *Lengerkeniola bischoffi* Nowicki, by monotypy. Originally as subgenus of *Lathromeroides*; currently synonym of *Lathromeroides*.

*Encyrtogramma* De Santis 1957. Type species: *Encyrtogramma habros* De Santis, by original designation. Currently as subgenus.

*Tanygramma* De Santis 1957. Type species: *Tanygramma xiphias* De Santis, by original designation. Currently synonym of *Lathromeroides*.

**Diagnosis.**—*Female.* Antenna with 2 anelli and an elongate, narrow club of 2 or 3 segments, basal club segment commonly



incompletely divided, club with numerous APB sensilla, both sexes lacking a terminal process at apex of club. Fore wing  $2.1\text{--}2.5\times$  as long as wide, fringe setae length variable ( $0.1\text{--}0.3\times$  FWW); venation short, attaining  $\leq 0.4$  distance to apex of wing, SV reduced, either short truncate and sessile to MV or, less commonly, represented by a slender appendix projecting from the marginal vein; disk densely setose, few if any arranged in linear tracks, RS1 absent. Hind wing with at least 3 complete linear setal tracks.

*Male.* GC with aedeagal AAP present or not; PAR absent, VS present but vestigial, lobiform; ventral setae present.

*Distribution.*—Worldwide, apparently most diverse in temperate areas. Of the three currently recognized New World subgenera, the nominate and *Lathromeroidea* occur throughout the hemisphere; *Encyrtogramma* is restricted to South America.

*Diversity.*—*Aphelinoidea* includes 36 species; nine have been described from the New World. These are partitioned among the three subgenera as follows: *Lathromeroidea* [*neomexicana* (Girault) (North America) and *xiphias* (De Santis) (South America)], *Encyrtogramma* [*habros* (De Santis) and *semiflava* De Santis, both South America], and the nominate subgenus [*oblita* De Santis (South America), *plutella* Girault, *roja* Triapitsyn, Walker and Bayoun, *semifuscipennis* and *zarehi* Triapitsyn, Walker and Bayoun (the latter four described from North America)]. In addition two Palearctic species of the nominate subgenus [*anatolica* Nowicki, *turanica* Trjapitzin] have been introduced into North America for biological control (Trjapitzin 1995). Identification of species of the nominate subgenus remains problematic with several species undescribed (Trjapitzin 1995). Partial keys to the U.S. species are provided by Trjapitzin (1995) and Walker et al. (2005).

*Discussion.*—*Aphelinoidea* is readily identified by the relatively narrow and highly setose fore wing which lacks linear setal

tracks, the reduced stigmal vein, the absence of a funicle and the two-three segmented antennal club which lacks a terminal process. It is most likely confused with *Tumidiclava*. Fore wing setation and venation as well as antennal structure are similar in both (see *Tumidiclava* for separation). *Aphelinoidea* may be more closely related to the *Brachygrammatella* group, although separation is straightforward owing to the presence of a funicle in the latter. Similarities include antennae with numerous APB sensilla on the club, densely setose fore wings, poorly developed stigmal vein, and similar male genitala. Interestingly, as in *Aphelinoidea*, the first postanellar segment in *Chaetogramma* is commonly incompletely divided.

The validity of the five subgenera requires study. For example, limits based on length of metasoma vs mesosoma for separating the nominate subgenus from *Lathromeroidea* appear to be artificial with intermediate undescribed species. The nominate subgenus also is inadequately defined. Trjapitzin (1995) divided the assemblage into two species groups, the *anatolica* group which includes the North American *A. plutella*, and the monotypic *semifuscipennis* group. Walker et al. (2005) recently changed the name of the *anatolica* group to the *plutella* group which is characterized by the presence of a hyaline path on the fore wing immediately apical to the venation. This modification is absent in the *semifuscipennis* group. Male genitalic variation also separates the two. Thus in the *plutella* group aedeagal apodemes are present, whereas they are absent in the *semifuscipennis* group. Apodemes also are present in *Lathromeroidea* and *Encyrtogramma*. The latter subgenus differs from the *plutella* group only by the distinct fore wing setation and color pattern; it also has a hyaline path on the fore wing. This renders the nominate subgenus paraphyletic at best and it appears that the *plutella* group should be transferred to *Encyrtogramma*. However, I hesitate to revise the

definition of these taxa until all subgenera can be considered.

*New World records.*—Subgenera (A/E/L) are indicated after each record. **Argentina:** Buenos Aires (E/L), Catamarca (A), Chaco (E), Formosa (A/E), La Pampa (E), La Rioja (A/E), Mendoza (E), Misiones (A), Salta (A/E), Tucuman (E). **Bermuda:** (A). **Brazil:** Rio de Janeiro (E), São Paulo (A). **Bolivia:** (A/E). **Canada:** Alberta (A/L), Manitoba (A), Northwest Territories (A), Ontario (A), Yukon Territory (L). **Chile:** Metropolitana (A), Region V (E), Region IX (A), Region X (A). **Costa Rica:** (A/L). **Ecuador:** (A/L). **Mexico** (A only): Baja California Norte, Baja California Sur, Campeche, Chiapas, Colima, Guerrero, Nuevo Leon, San Luis Potosi, Sinaloa, Tamaulipas, Veracruz. **United States:** Alabama (A), Arizona (A), California (A/L), Colorado (A), Florida (A), Georgia (A), Illinois (A), Indiana (A), Kansas (A), Louisiana (A), Maryland (A), Michigan (A), Missouri (A/L), Montana (A), Nebraska (A), Nevada (A), New Mexico (A), North Carolina (A), Oklahoma (A/L), Oregon (A/L), South Carolina (A), Texas (A/L), Utah (A/L), Virginia (A), Washington (A), Wyoming (A/L). **Uruguay:** (A/E/L). **West Indies:** (A).

*Hosts.*—Hemiptera: Cicadellidae (Trjapitzin 1995, Walker et al. 2005), Fulgoridae (Timberlake 1924).

## 24. *Bloodiella* Nowicki

*Bloodiella* Nowicki 1935. Type species: *Bloodiella andalusica* Nowicki, by original designation.

*Diagnosis.*—*Female.* Antenna with 1 anellus, 1 funicular and 3 club segments. Eyes reddish. Maxillary palp narrow, elongate, c.  $0.8\times$  mandibular length. Midlobe of mesoscutum and scutellum each with 2 pair of elongate setae. Fore wing very broad, c.  $1.6\times$  as long as wide; disk moderately densely setose with setae arranged in linear tracks, RS1 present. Metasomal tergum I (petiolar) without a transverse row of denticles.

*Male.* GC without aedeagal AAP, VS or PAR (Viggiani 1971, Fig. 5).

*Distribution.*—Palearctic, Africa?, South America?.

*Discussion.*—There are three species now assigned to *Bloodiella*, however the diagnosis above is based only on the type species, *B. andalusica*. This is because the other two are questionably placed. In the New World only *B. carbonelli* De Santis is included. *B. ormenidis* (Dozier), provisionally moved to *Bloodiella* (Doutt and Viggiani 1968), is now transferred to *Burksiella* (see below). The latter authors also questioned generic placement of the African species, *Bloodiella gynandrophthalmae* (Risbec). The assignment of *carbonelli* to *Bloodiella* may also be in error. Its unique holotype (in MLPA) was examined but because of the poor mount I am unable to verify number of funicle segments. It is possible that a small anelliform F1 can not be seen in the type, which, if present, also would require transfer to *Burksiella*.

*Bloodiella* is one of only three genera other than representatives of the Oligositini with one funicle and three club segments. The other two are *Soikiella*, and the African *Oligositoides*. Only *Soikiella* occurs in the New World. Unlike *Bloodiella*, *Soikiella* lacks an RS1 setal track, has a transverse row of denticles on metasomal tergum I, and has short aedeagal apodemes as well as parameres and volsellae in males. From the Oligositini, these three genera are separated by several features including the much broader fore wings, reddish eyes, and the two pair of setae on both the midlobe of the mesoscutum and the scutellum.

*New World records.*—**Uruguay** (holotype of *B. carbonelli*).

*Hosts.*—Unknown.

## 25. *Brachista* Walker (Figs 47, 124, 265)

*Brachista* Walker 1851. Type species: *Brachysticha fidiae* Ashmead, by subsequent monotypy. Pinto 1994 (revision).

*Brachysticha* Förster 1856. Unjustified emendation.

*Giraultiola* Nowicki 1936. Type species: *Brachysticha fidae* Ashmead, by monotypy. Pinto 1993 (synonymy).

**Diagnosis.**—Body elongate, relatively narrow. **Female.** Antenna with 2 anelli and a 4 segmented club, C1 as long or longer than C2 and bearing 1 PLS. Fore wing 2.1–2.5× as long as wide, fringe setae variable in length, 0.1–0.4× FWW; venation with SV well developed; disk moderately densely setose, setae relatively short and not obviously arranged in linear tracks, a distinct RS1 absent. Metasoma with 2 elongate ventrolateral strut-like apodemes extending anteriorly from near base of ovipositor (Fig. 265).

**Male.** Without strut-like metasomal apodemes. GC tubiform with a relatively elongate anterodorsal aperture; PAR, VS, ventral setae, and aedeagal AAP absent.

**Distribution.**—Known from the New World only, from Canada to Costa Rica, and SW Brazil.

**Diversity.**—Three species described: *B. fidae*, *B. efferae* Pinto, *B. fisheri* Pinto.

**Discussion.**—*Brachista* is most similar to *Uscana*. In both the antennal club is four segmented, and a funicle is absent. Also, in both, C1 is relatively elongate and bears at least one PLS. The two are separated by fore wing setation (linear tracks including RS1 present in *Uscana*; distinct tracks with RS1 absent in *Brachista*), and the absence of strut-like apodemes at the apex of the metasoma in *Uscana* females. The poorly known *Lathromeromyia* from Asia may also be close to *Brachista*; its females lack the characteristic metasomal apodemes as well. *Brachista* was studied by Pinto (1994). The rather tortuous history of its generic nomenclature also was reviewed (Pinto 1993).

**Records.**—**Brazil:** Rondonia. **Canada:** Quebec. **Costa Rica.** **Guatemala.** **Mexico:** Baja California Sur, Chiapas, Guerrero, Hidalgo, Jalisco, Michoacan, Morelos, Nayarit, Oaxaca, Sinaloa, Tamaulipas. **United States:** Arizona, California, Illinois,

Maryland, North Carolina, Ohio, Pennsylvania, Texas, Virginia. **West Indies.**

**Hosts.**—Coleoptera: Chrysomelidae (Ashmead 1894). Hemiptera: Cicadidae (Marlatt 1898). These records are for *B. fidae*. The other two species of *Brachista* are phoretic on Asilidae which may also serve as hosts (Pinto 1994).

## 26. *Brachygrammatella* Girault (Fig. 125)

*Brachygrammatella* Girault 1915. Type species: *Brachygrammatella nebulosa* Girault, by original designation. Doutt 1968 (generic review).

*Pseudbrachygramma* Girault 1915. Type species: *Pseudbrachygramma perplexa* Girault, by original designation. Doutt and Viggiani 1968 (synonymy; as subgenus, currently valid).

**Diagnosis.**—**Female.** Antenna with 2 anelli, 2 funicular and 1 or 2 club segments (often incompletely divided), F1 and F2 transverse, closely appressed but similar in length and width; PLS present on funicle, numerous short, fine APB sensilla on club. Fore wing wide,  $\leq 2\times$  as long as wide, fringe setae very short,  $\leq 0.1\times$  FWW; venation with base of MV and apex of PM poorly sclerotized, light in color, SV short, lacking a basal constriction, MV much broader than PM with numerous heavy setae dorsally; disk densely setose with considerable setation extending basally behind venation, distinct linear setal tracks absent or few in number, RS1 absent, costal cell well developed due to narrow PM. Ovipositor not extending beyond apex of metasoma.

**Male.** GC with vestigial, lobiform VS, ventral setae and aedeagal AAP present.

**Distribution.**—Australia, Asia and Africa. A single record from Mexico.

**Diversity.**—There are 11 species of *Brachygrammatella*; none is known from the New World. A single collection of two females from Mexico (UCRC), the only New World record, has not been identified.

**Discussion.**—Two subgenera currently are recognized (Doutt 1968). The characters used for subgeneric separation fail for



certain apparently undescribed species in the UCRC. The Mexican specimens however, are assignable to the subgenus *Pseud-brachygramma*.

*Brachygrammatella* is closely related to *Chaetogramma* and *Xiphogramma*. Differentiating characters and a discussion of generic limits are treated under *Chaetogramma*.

*New World records.*—**Mexico:** Sinaloa.

*Hosts.*—Hemiptera: Cicadellidae (Doutt 1968), Membracidae (Viggiani and Hayat 1974), Miridae (Viggiani 1968).

## 27. *Burksiella* De Santis, renewed status (Figs 69–71, 142, 161, 242, 243, 266–274)

*Burksiella* De Santis 1957. Type species: *Burksiella subannulata* De Santis, by original designation.

*Parahispidophila* Yousuf and Shafee 1988: 136. Type species: *Parahispidophila singularis* Yousuf and Shafee, by original designation. **New synonymy.**

*Diagnosis.*—*Female.* Antenna with 2 anelli, 2 funicular and 3 club segments (rarely reduced to 2 with only a partial division between C1 and C2); F2 as wide as or, more commonly, wider than C1, usually with more than 1 PLS; F1 short, transverse, closely appressed to F2; club segments distinctly asymmetrical (i.e., length of C1 and C2 in particular varying with surface), C1 without or, uncommonly (*benefica* group), with a single APB. Fore wing 1.7–1.9× as long as wide, fringe setae short ( $\leq 0.1 \times$  FWW); venation usually with a constriction between stigma and MV, SV extending apicad of apex of MV (a line drawn through middle of SV to wing margin describes an oblique angle with MV), MV 1.3–1.5× as long as PM and 0.9–1.7× as wide,  $SV+MV/PM > 1.5$  (usually  $> 1.75$ ), PM and base of MV not distinctly less sclerotized than apex of MV, radial process present; disk moderately densely setose, with distinct linear setal tracks, RS1 track elongate with more than 5 setae and broadly curved from apex of stigma to-

ward base of wing, apex of RS1 converging on Cu tracks.

*Male.* Antenna with club segments usually less asymmetrical; *benefica* group males with several APB on C1. GC reduced, gradually narrowed to apex, basal margin rounded; with or, more commonly, without ventral setae, PAR and aedeagal AAP; GL considerably less than HTL.

*Distribution.*—Oriental Region and New World. In the New World *Burksiella* is broadly distributed from Canada S to Argentina and Chile. Unlike the similar genus *Zagella*, it is most diverse in tropical areas where virtually all species are undescribed.

*Diversity.*—There are nine species assigned to *Burksiella* (see below). Seven occur in the New World and two are Asian. Numerous undescribed species exist; only one of these, *Burksiella diana* from North America, is described here.

*Discussion.*—*Burksiella* has been treated as a junior synonym of *Zagella* (Doutt and Viggiani 1964) and it is that genus which is most likely to be confused with it. Fore wing structure provides the easiest means of separation. In *Burksiella* (Figs 142, 161) the stigmal vein usually is constricted basally and always is projected apically beyond the end of the marginal vein. In *Zagella* (Figs 150, 162) on the other hand, the stigmal vein is not constricted and is perpendicular to the marginal vein rather than projecting apically. The length and orientation of the RS1 provide another difference. In *Burksiella* it is longer and curved posteriorly toward the base of the wing and converges onto the Cu tracks at its apex. In *Zagella* the RS1 has fewer setae and is relatively straight and roughly perpendicular to the Cu tracks. The longer, narrower marginal vein coupled with the greater extension of the stigmal vein apically also allows use of the ratio  $MV + SV/PM$  for generic separation. Antennal characters may also be useful. In most *Burksiella* C1 lacks APB sensilla and F2 is as wide or wider than the club; in *Zagella* APB

sensilla are always present on C1 and F2 is slightly narrower than the club. Males usually can be distinguished by genitalia. In *Burksiella*, the genital capsule gradually narrows to its apex and its basal margin is typically arcuate (Figs 242, 243); in *Zagella* the capsule more abruptly narrows near the middle and the basal margin is transverse or emarginate (Figs 254–256).

Although most likely confused with *Zagella* because of similar antennal formula, *Burksiella* appears more closely related to *Uscanoidea*. *Uscanoidea* is defined as having a five-segmented club but in certain species the distinction between funicle and club is not straightforward. Wing and male genitalia are similar in both groups and I have not discovered differences other than antennal formula.

As in certain other genera male genitalic variation in *Burksiella* is considerable. Most species are as in *B. spirita*. The genital capsule is simple, lacking parameres, ventral setae and aedeagal apodemes. In others such as *B. florida* and certain undescribed Latin American species, however, these structures are present.

Numerous New World species of *Burksiella* await description. The only species named are *Burksiella subannulata*, *B. diana* n. sp. (described below), *B. florida* (Viggiani) **new combination** (from *Zagella*), *B. spirita* (Girault) **new combination** (from *Zagella*), *B. platensis* (De Santis) **new combination** (from *Monorthochaeta*), *B. ormenides* (Dozier) **new combination** (from *Bloodiella*) and *B. benefica* (Dozier) **new combination** (from *Ufens*). The type material of all species was examined. It is possible that *Bloodiella carbonelli* De Santis, from Uruguay, belongs here as well but I am treating it under the original combination for now (see *Bloodiella*). *Burksiella ormenides*, originally described in *Ufens* by Dozier (1932), was provisionally transferred to *Bloodiella* by Doutt and Viggiani (1968). Examination of the type material of this species (NMNH) clearly shows two funicular segments, not one as is charac-

teristic of *Bloodiella*. All other traits support transfer to *Burksiella* as well.

Species of *Burksiella* occur in Asia. Included is *B. chrysomeliphila* (Lin) **new combination** (from *Zagella*) and *B. singularis* (Yousuf and Shaffee) **new combination** (from *Parahispidophila*). It should be noted that the illustration of the latter species in Yousuf and Shafee (1988, Fig. 24F) is misleading. It shows the two funicular segments as subequal in length. The holotype was examined (BMNH) and it is clear that F1 is much shorter than F2 as is typical of *Burksiella* and related genera.

*Burksiella* as defined here includes what can be referred to as the *benefica* group. This assemblage differs considerably from other species in that the sexes are highly dimorphic. Females resemble congeners, but as noted by Dozier (1932) in his description of *benefica*, males appear as a different species. They are larger, much lighter in color, and megacephalic. This group also differs in that C1 bears a single strong APB sensillum in females and males have several APB on this segment. APB sensilla are almost never present on C1 of other *Burksiella*. Although the West Indian *B. benefica* is the only species of the group described, two or three additional North American species are known. They are parasitoids of tettiioniid eggs.

*New World records.*—**Argentina:** Buenos Aires, Catamarca, Chaco, Córdoba, Formosa, Jujuy, La Rioja, Misiones, Salta, San Luis, Tucuman. **Belize.** **Bolivia.** **Brazil:** Guanabara, Mato Grosso do Sul, Minas Gerais, Rondônia, São Paulo. **Canada:** Alberta, Ontario, Quebec. **Chile:** Regions IX, X. **Colombia.** **Costa Rica.** **Ecuador.** **Guatemala.** **Mexico:** Aguascalientes, Baja California Sur, Campeche, Chiapas, Colima, Guerrero, Jalisco, Michoacan, Morelos, Nayarit, Nuevo Leon, Oaxaca, Quintana Roo, San Luis Potosí, Sinaloa, Tamaulipas, Veracruz, Yucatan. **Nicaragua.** **Peru.** **United States:** Arizona, California, Florida, Georgia, Illinois, Kansas, Louisiana, Maryland, Mississippi, Missouri, Nebraska,

New Hampshire, Nevada, North Carolina, Oklahoma, Oregon, South Carolina, South Dakota, Texas, Utah, Washington, Wyoming. **Venezuela. West Indies.**

*Hosts*.—Coleoptera: Chrysomelidae (Lin 1994). Hemiptera: Cicadellidae (Triapitsyn et al. 1998 and Triapitsyn 2003 [as *Zagella* in both], unpubl. records). Orthoptera: Tettigoniidae (Dozier 1932, unpubl. records).

***Burksiella diana* Pinto, new species**  
(Figs 266–274)

*Description*.—Body relatively compact, robust, length (card-mounted specimens) 0.4–0.5 mm; head broad, c.  $1.2\times$  greatest mesosomal width. Color dark brown except top and front of head, antennae and usually very base of metasoma yellow brown, metanotum usually white at middle; legs lighter at junction of femur and tibia; tarsi much lighter. *Female*. Mandible with 3 teeth, the two posterior teeth large, distinct, the anterior tooth short, obsolescent. Maxillary palp elongate, widest at base, c.  $5\times$  as long as wide, without a peg-like sensillum apically, terminal seta slightly longer than palp, subapical seta c.  $2/3$  palpal length. Antenna with 2 discoid anelli, funicle distinctly transverse and somewhat swollen, club subconical and 3 segmented; length/width of scape, pedicel, funicle and club: 43/15, 24/21, 27/34, 72/27; F1 closely appressed to F2, visible in medial view only; club widest at base, C1 and C2 asymmetrical, length/width of segments: 27/25, 40/30, 30/13; sensilla: BPS small, mushroom shaped, present on all postanellar segments, PLS on F2–C3 (4 on F2), APB on F1, F2 and near apex of C3, FS on all club segments, longest FS subequal to greatest club width, UPP at apex of club setiform.

Midlobe of mesoscutum elongate,  $1.2\times$  as long as wide; midlobe and scutellum each with 2 pair of moderately long setae, posterior pair on midlobe slightly more medially placed than anterior pair; sculpturing on midlobe and scutellum closely

lineate with several transverse interlineal connections on midlobe, relatively few on scutellum. Propodeum narrow, discal area only slightly produced posteriorly, subequal in length to metanotum. Fore wing broad, oblate,  $1.6\times$  as long as wide, venation attaining 0.5 FWL, fringe setae very short, c.  $0.05\times$  FWW; venation robust, MV c.  $1.4\times$  length of PM, gradually increasing in width to apex, c.  $2.5\times$  as long as wide, with a relatively large gap separating MV and PM; SV c.  $3/4$  length of MV, stigma suboval,  $SV+MV/PM = 1.6\text{--}1.7$ ; MV with 3 moderately long anterior and 4 shorter posterior setae dorsally, with 4 ventral setae; PM with 2 elongate setae and 2 campaniform sensilla at apex, PM considerably behind anterior wing margin forming a relatively large costal cell with several setae on its anterior margin and 1 or 2 posterior setae; disk moderately densely setose, almost all setae associated with linear tracks (c. 19 in number), RS1 present, broadly curved, basal track with 2 setae. Hind wing with 3 linear setal tracks. Metasomal terga lineate. Ovipositor relatively short, robust,  $OL/HTL = 0.8\text{--}1.0$ , gonoplac short, sharply and asymmetrically pointed at apex; hypopygium short, subtending only basal third of ovipositor.

*Male*. Antenna less robust than in female, club smaller, with C1 and C2 partially fused and with fewer sensilla. Metasoma distinctly swollen apically, distinctly bilobed. GC short, GL slightly less than half HTL, middle of basal margin with a short cuticular flange projecting anteriorly.

*Types*.—Holotype ♀ and allotype ♂. UNITED STATES. *California*: Riverside Co., Menifee Valley (hills on W side), 33° 19' N, 117° 13' W (1800' el.); vii-31-1995 (holotype), vii-12-1995 (allotype); Malaise trap; J. D. Pinto, collr.; in NMNH.

Paratypes: 2♀ with same data as holotype; 1♂ same data except vi-14/28-1995; 2♂ same except x-16/23-1982, xi-1/5-1981, 'pan trap under *Eriogonum gracile*'. Paratypes in CNC (1♂, 1♀) and UCRC (2♂, 1♀)



*Etymology*.—After my wife, Diana Gail Pinto.

*Distribution*.—United States and Mexico; from Washington state E to Illinois, S to southern Mexico.

*Comments*.—*Burksiella diana*e is unique. It is easily separated from *B. spirita*, the only other named North American *Burksiella*, as well as from all other species, described and undescribed. Both sexes are distinguished by the maxillary palp. In all other species the palp is shorter, but more significantly, bears on its apex in addition to a terminal seta, a distinct digitiform or peg-like sensilla (as in Fig. 172). In *B. diana*e, the elongate and tapered palp has a terminal seta only (Fig. 269). Males of *B. diana*e are distinguished from other species by the apically swollen and bilobed metasoma (Fig. 273). The dorsolateral metasomal surface in this area is membranous and appears to be densely porose. The short but distinct flange at the base of the genital capsule also appears to be unique (Fig. 274). The transverse funicle in females also helps separate this species from most other *Burksiella* where this segment is more elongate.

*Material examined*.—46♀ (44 on slides), 16♂ (15 on slides). MEXICO. *Colima*: Manzanillo; viii-8-1984; 1♀; G. Gordh. *Guerrero*: Acapulco, 30 km N; viii-6-1984; SP; 1♂; G. Gordh. *Michoacan*: Lazaro Cardenas, 100 km N; viii-7-1984; 1♀; G. Gordh. *Oaxaca*: Yagul Ruins; vii-13-1984; G. Gordh. *Sinaloa*: La Concha, 11 mi. N; x-25-1982; SP; 1♂; A. Gonzalez. *Veracruz*: Nautla, 33 mi. S; x-31-1982; 2♀; A. Gonzalez/J. Huber. UNITED STATES. *Arizona*: Bisbee, near; viii-27-1982; 1♀; J. LaSalle. Dragoon Mts. (Jordan Cyn., Cochise Co.); 31° 59' 33" N, 110° 01' 07" W; viii-11-2001; SP; 1♀; A. Owen. *California*: Altadena; vi-9-1991, vi-28/viii-25-1990; 3♀; R. Crandall. Anza Borrego State Park (Coyote Cyn., San Diego Co.); iv-15-1981; 1♀; J. Huber. Baker, 5.6 mi. SW (at Zzyzx Rd. exit off of I-15); iii-30-1989; 'sweeping *Larrea*, *Bebbia*, etc.'; 1♂; J. Pinto. Big Pine, 1.1 mi. E (3950' el.); 37° 10.39' N, 118° 16.28' W; v-26-2002; 'swp. primarily *Salix*'; 1♀; J. Pinto. Big Pine, 2 mi. E; vii-12-1993; 'swp. *Salix*, etc. along Owens River'; 2♀; J. Pinto.

Menifee Valley (hills on W. end); 33° 39' N, 117° 13' W; vi-7/13-1995, x-6/11-1981, x-16/23-1982, xi-1/8-1982; MT, 'pan trap under *Eriogonum*'; 2♂, 3♀; J. Pinto. Same locality; 3♀, 4♂ (see Types). Pozo, 6 mi. SE (1500'); iv-1/v-4-1990; 1♀; MT; W. Wahl. Santa Rosa Plateau Ecological Reserve (590 m) (Riverside Co.); 33° 52.524' N, 117° 14.644' W; iv-7/iv-28-2002, iv-29/v-29-2002 ix-20/x-12-2001, xi-1/22-2001; MT #2; 4♀, 2♂; J. Pinto. Spanish Flat, 3 mi. SSW on Capell Creek (Napa Co.); vi-11-1984; SP; 1♀; J. Pinto. Wildhorse Mdw. (San Bernardino National Forest, San Bernardino Co.) (2357 m); 34° 10.47' N, 116° 44.48' W; viii-7-2002; 'yellow pans riparian, dry scrub'; 1♀, 1♂; A. Owen/J. Pinto. *Nevada*: Valley of Fire State Park (1 mi. west of W entrance); iii-20-1989; 'sweeping flowering plants'; 1♀; J. Pinto. *Florida*: Everglades N. P. (Lone Pine Key pinelands); vi-6/viii-26-1986; 1♀; S./J. Peck. Hollywood; xii-22-1982; sweep; 1♀; W. Gregory. *Illinois*: Garden of the Gods (Harden Co.); vi-19-1991; 'swp. wooded area'; 1♂; J. Pinto. *Oregon*: Christmas Valley, 13.5 mi. SW; viii-5-1995; 'swp. 1' *Chrysanthamnus*'; 1♀; J. Pinto. La Pine, 24 mi SE (jct. Hwy 35 & Rd. 3125); viii-5-1995; 'swp. *Chrysanthamnus* etc, in pine forest'; 3♀; J. Pinto. *South Carolina*: Lakeshore, near; vii-25/31-1987; FIT; 1♀; J. Johnson. *Texas*: Ben Bolt, 8 mi. W (Copita Research Station); v-20-1987, ix-28/30; 4♀, 1♂; J. Woolley. Big Bend National Park; (Rosillos Mts.); vii-17-1991; 1♀; R. Vogtsberger. Big Bend Ranch SNA (Presidio Co.), McGuirk's tank (4360'); 29° 28' 34" N, 103° 49' 12" W; vi-19-1990; 1♀; J. Woolley. Big Bend Ranch SNA (4400'); 29° 30' 45" N, 103° 51' 56" W; vi-21-1990; 3♀, 1♂; J. Woolley/G. Zolnerowich. Same except: 29° 30' 20" N, 103° 52' 20" W; vi-22-1990; 1♀. *Washington*: Goldendale; vii-21-1988; 'sweep poplar, willow, etc.'; 1♀; J. Pinto. *Wyoming*: Rawlins, 17 mi. E (1.5 mi N of I-80 at North Platte River); vii-7/ix-2-1991; MT; 2♀; S. Shaw.

## 28. *Centrobiopsis* Girault, renewed status (Figs 79, 80, 148, 251)

*Centrobiopsis* Girault 1918. Type species: *Centrobia odonatae* Ashmead, by original designation. Doutt and Viggiani 1968 (as synonym of *Lathromeroidea*).

*Diagnosis*.—*Female*. Body elongate, slender, ovipositor extending considerably beyond apex of metasoma. Antenna with 2

anelli and 5 club segments, C1 anelliform, closely appressed to C2, C2 loosely associated with C3 (may appear as a funicular segment). Fore wing c.  $2\times$  as long as wide, fringe setae  $0.1\times$  FWW; venation attaining  $0.5$  FWL, SV constricted at base and extending apicad of MV, MV  $1.5\times$  length of PM and subequal in width,  $SV+MV/PM = 1.8$ ; disk moderately densely setose, with distinct linear setal tracks, RS1 elongate, broadly curved from apex of stigma toward base of wing, its apex converging on Cu tracks. Propodeal disk length subequal to that of metanotum. Fore tibia not spined on dorsal surface. Ovipositor elongate, extending entire length of metasoma, c.  $\frac{1}{4}$  its length extending beyond metasomal apex.

*Male.* GC elongate, slender, its length c.  $1.6\times$  HTL, with an elongate, longitudinal furrow on ventral surface; PAR, VS, ventral setae and aedeagal AAP absent.

*Distribution.*—North America.

*Diversity.*—The only named species is *Centrobiopsis odonatae*, **renewed combination** (from *Lathromeroidea*). One additional undescribed species has been collected from southern Mexico.

*Discussion.*—*Centrobiopsis* is not highly distinctive yet it is not easily placed in any other genus. Its body and genitalia are elongate, with both the male genital capsule and ovipositor considerably longer than the hind tibia. In these respects it resembles *Chaetostricha*. Unlike *Chaetostricha*, however, a distinct funicle is absent, the fore tibia is not spinose, and although the male genital capsule is narrow and exceptionally elongate in both, only in *Centrobiopsis* is the ventral surface furrowed (cf. Figs 245, 251).

Doutt and Viggiani (1968) synonymized *Centrobiopsis* with *Lathromeroidea*. However, unlike *Lathromeroidea*, in *Centrobiopsis* the fore wing fringe is very short, it lacks the conspicuous basal convergence of setal tracks characteristic of *Lathromeroidea* in the original sense, and unlike most species of that genus, its propodeal disk is sub-

equal in length to that of the metanotum. The unique male genitalia further distances it from *Lathromeroidea* and all other genera of the *Chaetostricha* group. Affinity seems closer to *Uscanoidea*, which shares most of the fore wing characteristics as well as the shorter propodeal disk. Although similar to both genera as well as to *Burksiella*, *C. odonatae* is not easily placed in any one of them without considerably modifying generic definitions.

Ashmead's type of *C. odonatae* (examined, NMNH) is incomplete. Only a fore and hind wing, and one antenna remain.

*Records.*—**Canada:** Ontario, Quebec. **Mexico:** Quintana Roo. **United States:** Illinois.

*Hosts.*—Odonata: Lestidae (Ashmead 1900, several unpubl. records).

## 29. *Chaetogramma* Doutt (Figs 48, 49, 126, 193, 229, 230)

*Chaetogramma* Doutt 1974. Type species: *Chaetogramma occidentalis* Doutt, by original designation.

*Chaetogrammina* Hayat 1981 (as subgenus, currently valid). Type species: *Chaetogramma* (*Chaetogrammina*) *maculata* Hayat, by original designation.

*Brachistagrapha* De Santis 1997. Type species: *Brachistagrapha caudata* De Santis, by original designation. Pinto and Viggiani 2004 (synonymy).

*Diagnosis.*—*Female.* Antenna with 2 anelli, funicle and 1 club segment, funicle consisting of 2 subequal closely appressed segments or a single partially divided segment; PLS present on funicle, with numerous short, fine APB sensilla on club. Fore wing venation with base of MV and apex of PM poorly sclerotized, light in color, SV short, lacking a basal constriction, MV without numerous heavy setae dorsally; disk densely setose but dense setation not extending basally to area behind venation, with linear setal tracks poorly indicated, RS1 absent. Ovipositor shorter than metasoma and not extending beyond its apex.

*Male.* GC with vestigial, lobiform VS, ventral setae present; aedeagal AAP present or not.

*Distribution.*—Asia, Africa, North and temperate South America.

*Diversity.*—Six species are assigned currently to *Chaetogramma*. Only two occur in the New World, *Chaetogramma occidentalis* and *C. caudata* (De Santis). Both belong to the nominate subgenus. The latter species was designated as the type of *Brachistagrapta* by De Santis (1997) who erroneously assigned it to the Oligositini (Pinto and Viggiani 2004).

*Discussion.*—*Chaetogramma* is closely related to *Brachygrammatella* and *Xiphogramma*. Generic limits in this complex (= *Brachygrammatella* group) require clarification. In general, *Brachygrammatella* is defined by the broad, dorsally spinose marginal vein (Fig. 125), the larger costal cell (due to reduction of PM width), the transverse funicular segments, and the basal extension of the dense discal setation of the fore wing into the region behind the venation. *Brachygrammatella* is the only genus in the group that may have a two-segmented club. *Xiphogramma* is characterized by the absence of *Brachygrammatella* features and its elongate ovipositor which extends considerably beyond the apex of the metasoma (Fig. 195). *Chaetogramma* is distinguished by the absence of the presumably derived features characterizing *Brachygrammatella* and *Xiphogramma*. In *Chaetogramma* the funicle is two segmented with F1 and F2 partially (*C. Chaetogramma*) (Figs 48, 49) or completely (*C. Chaetogrammina*) divided. Male genitalia are similar in all three genera. Although aedeagal apodemes are present or absent in this group, variation does not coincide with generic limits. Thus, apodemes are absent in *Xiphogramma fuscum* (Fig. 239) and *C. maculata*, but present in *X. annekei* and *C. occidentalis* (Fig. 229); they also are present in *Brachygrammatella* (Viggiani 1971). Males are unknown for *X. indicum* Hayat and *X. holorhoptra* Nowicki.

Hayat (1981) recognized the Asian subgenus *Chaetogrammina* primarily by the completely divided funicle, discernable setal tracks basally in the fore wing, and a better developed costal cell. As indicated by Pinto (1990b) these traits also characterize *Xiphogramma*. The only difference between *Chaetogramma* and *Xiphogramma* is the longer ovipositor in the latter.

Intermediate states and lack of consistency in features used by Doutt (1968, 1973) and Doutt and Viggiani (1968) to distinguish *Brachygrammatella*, *Xiphogramma* and *Chaetogramma* render these genera difficult to define on a world-wide basis (Pinto 1990b). Studies of material from Asia, Africa and Australia, where the bulk of the species occurs, is needed. Problematic generic limits currently do not affect the New World fauna from a practical standpoint where only two closely related species of *Chaetogramma*, and one species of *Xiphogramma* and of *Brachygrammatella* are known.

*New World records.*—**Argentina:** La Rioja, Salta, Misiones. **Canada:** Alberta, Manitoba, New Brunswick, Ontario, Prince Edward Island. **Chile:** Region X (Isla Chiloé). **Costa Rica.** **Mexico:** Baja California Norte, Colima, Guerrero, Jalisco, Morelos, Nuevo Leon, Sinaloa, Tamaulipas, Yucatan. **United States:** Arizona, California, Colorado, Louisiana, Montana, Oregon, Texas, Virginia, Washington. **West Indies.**

*Hosts.*—Unknown.

### 30. *Chaetostricha* Walker (Figs 72, 143, 244, 245)

*Chaetostricha* Walker 1851. Type species: *Chaetostricha dimidiata* Walker, by monotypy.

*Centrobria* Förster 1856. Type species: *Trichogramma walkeri* Förster, by monotypy.

*Centrobiella* Girault 1912. Type species: *Centrobiella mulierum* Girault, by original designation.

*Ratzburgalla* Girault 1938. Type species: *Parnifens spinosus* Girault, by original designation.

*Diagnosis.*—*Female.* Body usually slender and elongate; head relatively narrow,



narrower than mesosoma; ovipositor usually extending beyond metasoma. Antenna with 2 anelli, 2 funicular and 3 club segments; F1 short, transverse, closely appressed to considerably longer F2; F2 longer than wide to as wide as long, narrower than C1 (uncommonly subequal in width), with 1 PLS (rarely absent); club segments relatively symmetrical, almost always without APB sensilla on C1. Fore wing  $1.8\text{--}2.1\times$  as long as wide, fringe length  $0.08\text{--}0.20\times$  FWW; venation elongate, attaining at least  $0.5$  FWL, MV elongate,  $\geq 1.2\times$  length of PM;  $SV+MV/PM \geq 1.5$  ( $1.5\text{--}2.3$ ), SV constricted at base, extending apical of MV, stigma often suboval; disk moderately densely setose with distinct linear setal tracks, RS1 elongate, usually straight and directed toward wing base. Fore tibia with a prominent spine at middle of dorsal surface (absent in some Australian species), if more than one spine present then middle spine most prominent.

*Male.* GC narrow, tubular, usually extremely elongate, GL subequal to or greater than HTL, not furrowed ventrally, without VS, PAR, ventral setae and aedeagal AAP.

*Distribution.*—Widespread except unknown from Central and South America.

*Diversity.*—The genus includes 21 species. Only *C. thanotophora* Pinto, has been described from the New World but several additional undescribed forms occur (Pinto 1990a).

*Discussion.*—As already noted *Chaetostricha* is superficially similar to *Centrobiopsis*. Body shape, ovipositor length and male genitalia are similar in both (see *Centrobiopsis* for differences). The relatively slender body shape of *Chaetostricha* separates it from similar genera such as *Burksiella* and *Uscauioidea*. They can also be separated by the fore wing features typical of their genus and by the genital capsule length which is considerably less than that of the hind tibia. Although the dorsum of the fore tibia may be spinose in a few *Uscauioidea*, the absence

of a single prominent spine at the middle also separates it from *Chaetostricha*.

The synonymy of *Centrobia*, *Centrobiella*, and *Ratzeburgalla* with *Chaetostricha* proposed by Doutt and Viggiani (1968) is followed here. I examined the types of *Centrobiella* and *Ratzeburgalla* (QM) more than 15 years ago. The types of both are in poor condition and, although consistent with the definition of *Chaetostricha*, I was unable to verify certain defining characteristics (e.g. presence of two funicular segments).

*New World records.*—**Canada:** British Columbia, Ontario, Quebec. **Mexico:** Guerrero, Morelos. **United States:** Arizona, California, Florida, Michigan, Missouri, Nevada, Oregon, Texas, Utah, Washington. **West Indies.**

*Hosts.*—Hemiptera: Membracidae (Srivastava et al. 1970), Miridae (Pinto 1990a, Sundararaju 1993).

### 31. *Lathromeris* Förster (Figs 50, 127, 231, 262–264)

*Lathromeris* Förster 1856. Type species: *Lathromeris scutellaris* Förster, by monotypy.

*Lathromerella* Girault 1912. Type species: *Lathromerella fasciata* Girault, by original designation.

*Garouella* Risbec 1956. Type species: *Garouella ovicida* Risbec, by monotypy.

*Diagnosis.*—*Female.* Antenna with 2 anelli and a 5-segmented club, C5 ending in a pronounced terminal process. Fore wing  $2.1\text{--}2.5\times$  as long as wide, fringe setae  $0.2\text{--}0.3\times$  FWW; venation with an elongate, straight MV and a distinct SV; disk moderately densely setose, linear tracks present but indistinct, RS1 absent or rarely poorly indicated. Hypopygium variable but often prolonged as a narrow projection extending beneath ovipositor.

*Male.* Antenna without a terminal process. Metasomal terga VI and VII with a modified area on either side of midline. GC with PAR present or not, ventral setae present, VS apparently absent; aedeagal AAP present.

**Distribution.**—Known from all continents. In the New World the genus is known only from the United States, Costa Rica, Canada and Argentina. It appears to be uncommon in the neotropics.

**Diversity.**—There are 23 species assigned to *Lathromeris*; most occur in Australia, Asia and Europe. Only *L. argentina* De Santis, a South American species, has been described from the New World. A distinctive North American representative, *L. hesperus*, is described below. Several additional species, apparently also new, are known from North America. Certain Australian species may be inappropriately placed in *Lathromeris* (see below).

**Discussion.**—*Lathromeris* is most likely confused with *Tumidiclava* and *Nicolavespa*. All three have a pronounced terminal process on the female antennal club. Male genitalia also are comparable in these genera, and *Tumidiclava* males, as in those of *Lathromeris*, have similarly modified metasomal terga. *Tumidiclava* is separated by its extremely short stigmal vein which lacks a constriction between the stigma and marginal vein; also females of *Tumidiclava* have fewer than five antennal club segments and males frequently do as well. *Nicolavespa* has a distinct funicle and its males lack modifications of the metasomal terga.

It is likely that certain Australian species assigned here are misplaced. Girault (1912) defined *Lathromerella*, a junior synonym of *Lathromeris*, as having a five-segmented club and considered the terminal process at its apex in females to vary within the genus (e.g. Girault 1915). He erroneously considered *Pteryogrogramma* as having a three-segmented club (Girault 1912). The club is five-segmented in both genera but the terminal process is lacking only in *Pteryogrogramma*. Consequently it appears that Girault placed certain species of *Pteryogrogramma* in *Lathromerella* if the five-segmented club was detected. Species likely to have been misplaced include *L. lucida* Girault, *L. occidentalis* Girault and *L. ovata* Girault.

**New World records.**—**Argentina:** Buenos Aires (De Santis 1957). **Canada:** Alberta, British Columbia, Ontario, Prince Edward Island, Quebec. **Costa Rica.** **United States:** Arizona, California, Idaho, Illinois, Missouri, Nevada, Ohio, Oregon, Pennsylvania, Texas, Utah, Virginia, Wisconsin. See description of *L. hesperus* for specific localities of that species.

**Hosts.**—Diptera: Cecidomyiidae (Vigiani and Laudonia 1994). Lepidoptera: Noctuidae, Pyralidae (Polaszek et al. 1998). The cecidomyiid record of larval parasitism is a documented exception of eggs serving as host in the Trichogrammatidae.

***Lathromeris hesperus* Pinto, new species**  
(Figs 50, 127, 231, 263)

**Description.**—**Female.** Body relatively elongate, length 0.6–1.1 mm (N=5), metasoma almost twice length of mesosoma. Color dark brown to almost black except petiolar area, vertex and front of head yellow, antenna light brown, base and apex of femora and tibiae and tarsomeres I and II light yellow, fore wing disk colorless with a broad fumate fascia extending across wing behind MV and SV.

Antenna slender; length/width of scape, pedicel and club: 38/11, 24/14, 68/14; A1 cupuliform, longer than disciform A2 which is closely appressed to C1. Club narrow, surface with straight, obsolescent longitudinal wrinkles; C1–C3 slightly wider than long, C4 slightly longer than wide, C5 much longer than wide, terminal process short,  $0.2\times$  length of C5, width of segment at base of terminal process subequal to width of process itself; C2–C5 relatively symmetrical, C1 somewhat less so; length/width of club segments: 14/18, 16/20, 19/20, 23/16, 43/8. Club sensilla relatively sparse: C1 and C2 with few APA, APB, and 1 BPS near apex, C3 similar but with BPS considerably below apex and a few FS distally, C4 with FS, APB and BPS also below apex, C5 apparently with 2 RS

at apex attaining tip of terminal process; 2-3 PLS on C4 and C5, terminal process with a short UPP at apex. Mandible quadridentate with anterior-most tooth markedly less well sclerotized, lobiform. Maxillary palp subcylindrical, c.  $3\times$  as long as wide, with a narrow, cylindrical sensillum at apex (c.  $0.4\text{--}0.5\times$  length of palp), terminal seta slightly longer than palp.

Midlobe of mesoscutum with 2 pair of moderately long, subequal setae, posterior pair considerably more medially placed. Scutellum with anterior pair of setae short, only c.  $0.2\times$  length of posterior pair. Sculpturing on midlobe consisting of relatively large subpentagonal or hexagonal cells except surface more longitudinally rilled at middle of basal half; scutellum with all sculpturing longitudinal. Propodeum relatively short, c.  $2\times$  as long as metanotum at middle, discal area not produced. Fore wing  $2.5\times$  as long as wide, venation attaining  $0.6$  FWL, fringe setae moderately elongate, c.  $0.3\times$  FWW; venation elongate, narrow, MV  $2\times$  as long as PM, SV c.  $0.3\times$  length of MV, slanting away from MV at an angle slightly greater than  $90^\circ$ , with only a slight constriction between stigma and MV; MV with 3 elongate dorsal and 7 short ventral setae; apical half of PM and basal third of MV poorly sclerotized, colorless; disk moderately densely setose in area apical to venation, setae short especially posteriorly, linear setal tracks present but poorly indicated, linear tracks more distinct in anterior section of wing; costal cell without setae. Hind wing with 3 linear setal tracks, setae short. Ovipositor moderately long, not extending beyond apex of metasoma,  $OL/HTL = 2.0$  ( $1.7\text{--}2.2$ ) ( $N=5$ ), gonoploc  $< 0.2$  OL; hypopygium short, c.  $0.2$  OL.

*Male.* Body length  $0.6$  mm ( $N=1$ ). As female except C5 without a terminal process and considerably shorter and wider relative to C4 (subequal in length and  $0.7\times$  its width), C4 with APA and C5 with FS. Metasoma with unique pair of laterally longitudinally arranged tubiform struc-

tures beneath surface of terga VI and VII, each tube extending posteriorly from an oval saclike structure near base of V to near apex of VI, tubes then curving toward midline but not obviously joining. GC with length  $0.5\times$  HTL, ADA c.  $0.4\times$  GL, ventral setae present, PAR absent; aedeagal AAP present.

*Types.*—Holotype ♀ and allotype ♂. UNITED STATES. *California*: Riverside Co., Menifee Valley (hills on W. side),  $33^\circ 39' N$ ,  $117^\circ 13' W$  ( $1800'$ ); vi-7/13-1995 (holotype), vi-14/28-1995 (allotype); MT; J. D. Pinto, coll.; in NMNH. Paratypes (2♂, 9♀), same data except four with additional dates (vii-12-1995, vii-31-1995); deposited in CNC, BMNH and UCRC.

*Etymology.*—Hesperus (Gr.), classical name of the 'evening star', in reference to the western distribution of this species.

*Distribution.*—Western United States; Oregon, Nevada and Utah to southern California

*Comments.*—Both sexes of *Lathromeris hesperus* are readily distinguished from congeners. In females C5 is very narrow and narrows considerably towards the apex where its width at the base of the terminal process is subequal to the width of the process itself. This results in the base of the terminal process being difficult to discern (Fig. 50). The short hypopygium, the very dark brown coloration, fasciate fore wings (Fig. 127), and the distinctive mesosomal sculpturing also helps separate females. Males are distinguished by the pair of unique tubiform structures beneath metasomal terga V and VI (Fig. 263). Males of all other species known to me either have large subquadrate pustules or mamelliform evaginations associated with the apex of the metasoma (Figs 262, 264). Females of *Lathromeris argentina*, the only other described New World species, has a considerably broader C5, and lacks the fasciate fore wing. Its male is unknown.

*Material examined.*—54♀ (18 on slides), 7♂ (6 on slides). UNITED STATES. *California*: Del Loma,  $\frac{1}{4}$  mi. E (Erv Pigg property) (Trinity Co.); ix-1/3-



1995; MT nr. forest edge; 2♀; S. Polly/G. Platner. Granite Mountain Reserve (Granite Cove, c. 4200') (San Bernardino Co.); 34° 48' N, 115° 39' W; SP; 1♀; G. Platner. Lake Skinner, NE (Riverside Co.); 33° 35' 58" N, 117° 01' 58" W (c. 1570'); iv-24/v-8/1997, vi-4/18-1996; MT in 'coastal sage scrub'; 3♀, 2♂; J. Pinto. Same except 33° 36' 04" N, 117° 02' 18" W (c. 1580'); v-22/vi-5-1997, vi-18/vii-2-1998, vii-2/16-1998; 7♀, 2♂; J. Pinto. Menifee Valley (hills on W. side) (Riverside Co.); 10♀, 3♂; see Types [additional material from type locality on cards: vi-7/13-1995, vi-14/28, vi-28/vii-12-1995, vii-19/viii-1-1995; MT; 20♀; J. Pinto]. Riverside (UCR campus); v-2-1984; 1♀; J. LaSalle. Santa Rosa Plateau Ecological Reserve (590 m) (Riverside, Co.), 33° 32.524' N, 117° 14.644' W; MT; vii-30/viii-14-2001; 1♀; PEET Survey. Tamarack Valley (San Jacinto Mts., 9120') (Riverside Co.); 33° 48.61' N, 116° 39.63' W; SP; viii-13/17-2001; 1♀; J. Pinto/G. Platner. Valyermo (Los Angeles Co.); viii-30-1989; SP; 1♀; R. Crandall. *Nevada*: Alamo, 17 mi. S (Lincoln Co.); v-22-1995; 'scrn. swp. desert veg.'; 1♀; J. Pinto. Winters, 11 km W (Cold Canyon Reserve, Solano Co.); viii-1/15-1994; MT, 'live oak woods'; 4♀; L. Kinsey. *Oregon*: Brookings, near (Timeus Ranch, Curry Co.); 42° 06' N, 124° 17' W; ix-1/15-1995; MT; 1♀; M. Wasbauer. *Utah*: Caineville, 6 mi. W (along Fremont River, c. 4700') (Wayne Co.); vi-29-1993; SP; 1♀; J. Pinto.

### 32. *Lathromeroidea* Girault

(Figs 6, 73–77, 144–146, 164–167, 180, 181, 183, 191, 196, 246–249, 261)

*Lathromeroidea* Girault 1912. Type species: *Lathromeroidea nigra* Girault, by original designation.

*Diagnosis.*—*Female*. Body shape variable but usually more elongate and slender than similar genera (*Uscanoidea* and *Burksiella*). Antenna with 2 anelli and a 5-segmented club, C1 shorter and narrower than C2 and usually closely appressed. Fore wing 1.9–2.5× as long as wide, fore wing fringe  $\geq 0.20\times$  FWW in most species; venation similar to that in *Burksiella* and *Uscanoidea*, SV projecting apically beyond apex of MV; disk moderately to densely setose, RS1, usually distinct, typically straight, not curving greatly from stigmal vein to in-

tersection with Cu tracks; propodeal disk elongate, longer than metanotum, usually at least twice as long.

*Male*. Eyes smaller than in female (cf. Figs 165, 166). GC short, GL less than HTL, without PAR, VS and aedeagal AAP, ventral setae present.

*Lathromeroidea* is herein divided into three groups (see Discussion).

*Distribution.*—Widespread.

*Diversity.*—Nine species. Seven have been described; two new species, the only named New World species, are added here. Although exceptionally diverse in the New World, none of its species has been previously described. Doutt and Viggiani (1968) did place *odonatae* in *Lathromeroidea*, however it is herein returned to *Centrobiopsis* (see above).

*Discussion.*—*Lathromeroidea* is similar to and unsatisfactorily separated from *Uscanoidea*. Differences are discussed under the latter. Doutt and Viggiani (1968) suggested alliance with *Neolathromera* as suggested by similar wing and antennal structure. Neither Doutt and Viggiani nor I have seen material of *Neolathromera*. In my opinion, based on the original description, *Neolathromera* may be closer to *Pterygogramma*. Although the antennal club is 5 segmented in all three, in *Lathromeroidea* C1 is much shorter than C2, not much longer as in *Neolathromera* and *Pterygogramma*. Males of *Neolathromera* are unknown.

As defined here, *Lathromeroidea* is a very complex genus with high diversity. The variation among species is considerable, yet clear-cut divisions in the group are not obvious. Rather than erect new genera, perhaps prematurely, I divide the genus into three informal phenetic species groups A, B and C based on fore wing structure alone. Groups A and B are widespread in distribution; C is known only from the New World. All previously described species belong to Group A. Groups A and C at least, appear to be associated with aquatic habitats. Exemplar species of groups B and C are described below.

Characteristics and comments regarding the three assemblages follow.

**Group A.** Fore wing (Fig. 144) c.  $2.3\times$  as long as wide, fringe setae c.  $0.3\times$  FWW; venation attaining 0.5 FWL, with MV  $1.5-1.8\times$  length of PM,  $SV+MV/PM = 2.0-2.4$ , apex of SC terminating above base of PM; disk moderately densely setose, with a basal convergence of setal track RS1 and most of the other tracks posterior to r-m; a line of setae present immediately anterior of the retinaculum; a narrow but distinct costal cell present with more than 3 setae; venation with a distinct constriction between the MV and stigma. Figs 73, 144.

This group includes the type species. All even of the previously described species of *Lathromeroidea* belong here. These species occur in Australia, Europe and Asia. The New World representatives of Group A are very similar to those in other parts of the world. Revisionary studies are needed to determine which, if any, are conspecific to described species.

**Group B.** Club segments usually more symmetrical in female. Fore wing (Fig. 145) often wider than in congeners,  $1.9-2.4\times$  as long as wide and fringe setae often shorter ( $0.2-0.4\times$  FWW); venation attaining 0.5 FWL, MV length  $1.5-2.0\times$  that of PM;  $SV+MV/PM = 2.0-2.3$ , apex of SC terminating above base of PM; disk less densely setose than in the other groups, without a conspicuous convergence of vein tracks basally, at most only RS1 and Cu tracks converging toward base of wing, usually without a distinct line of setae anterior to retinaculum, rarely more than 3 setae in costal cell. Midlobe of mesoscutum with posterior setae slightly medial to anterior pair; scutellum not abruptly depressed anterolaterally; metasomal tergum not longitudinally divided, its anterior margin relatively straight. Figs 6, 74-76, 145, 164, 174, 181, 183, 191, 249.

This group includes the least modified species of the genus and the most likely to be confused with *Uscanoidea*. It is considerably diverse in the New World tropics

where perhaps it is the most frequently collected group of Trichogrammatidae. A single representative, *L. exemplum*, is described below to characterize the group. Although apparently not common elsewhere, I have examined species belonging here from North America, Australasia and Africa.

**Group C.** Body much more heavily sclerotized than congeners and other trichogrammatids. Head of both sexes with a unique deep and relatively large pit immediately in front of anterior ocellus (Figs 165-167). Fore wing (Fig. 146) narrower,  $2.3-2.5\times$  as long as wide, fringe setae  $0.3-0.4\times$  FWW; venation attaining 0.4 FWL, MV  $1.3-1.6\times$  length of PM,  $SV+MV/PM = 1.5-1.8$ , SV sessile to MV or with only slight constriction at base, SC and PM confluent, PM closer to wing margin and costal cell absent or extremely narrow; disk densely setose, setal tracks indistinct or obvious only in a narrow band anteriorly and posteriorly, without a line of setae anterior to retinaculum. Midlobe of mesoscutum with posterior pair of setae lateral to anterior pair; scutellum strongly depressed anterolaterally and appearing laterally emarginate in dorsal view (Fig. 180). Metasomal tergum II (first visible) usually elongate and longitudinally divided at middle, extending ventrally to overlap much of anterior sternal plates, with a unique oval, clear bulla anterolaterally (Fig. 196); last sternum of both sexes divided apically with each lateral lobe produced into an acute posterior projection (Fig. 261). Figs 77, 146, 165-167, 180, 196, 246-248, 261.

The cephalic pit of Group C is unknown in any other Trichogrammatidae. However a very similar structure, termed the pre-ocellar pit, occurs in the Scelionidae, Megaspilidae and Ceraphronidae (Bin and Dessart 1983). The ultrastructure of this pit has been examined in the scelionid *Trissolcus basalis* (Woll.) by Isidoro and Bin (1994). In this species the pit is manifested internally as an apodeme connected to the protocerebrum by a bun-

dle of microtubule-rich epidermal cells. Isidoro and Bin assume that this structural complex provides mechanical support for the brain.

Group C is the most distinctive and is known only from the New World. Its differences suggest generic or subgeneric status. Three traits alone, the strongly sclerotized body, the precellar pit and the presence of metatergal bullae, are unique within the family. Whereas the limits between groups A and B, and between Group B and *Uscanoidea* are not clear, Group C would appear to be easily characterized. Yet, as defined, Group A includes certain species which have fore wing structure typical of its group but scutellar and certain metasomal characteristics of Group C. Therefore, before partitioning, I believe the entire *Lathromeroidea* complex as well as its relationship to *Uscanoidea* warrant careful study.

*New World records.*—Group(s) are indicated after each record. **Argentina:** Misiones (A/B). **Belize** (A/B). **Bolivia** (A/B). **Brazil:** Goiás (A/B), Rondonia (B). **Canada:** Alberta (C), Ontario (C), Quebec (C). **Colombia** (A, B). **Costa Rica** (A/B/C). **Ecuador** (A/B). **Guatemala** (B). **Mexico:** Chiapas (B), Michoacan (B), Tamaulipas (B), Quintana Roo (A/B), Veracruz (A). **Panama** (A/B/C). **Paraguay** (A). **Peru** (B). **United States:** Arizona (A), Florida (A/B/C), Georgia (A/C), Kentucky (C), Missouri (A/C), New Mexico (A), South Carolina (B/C), Utah (B). **Venezuela** (A/B/C). **West Indies** (A/B). See descriptions of *L. exemplum* and *L. gerriphaga* for specific records of those species.

*Hosts.*—Hemiptera: Gerridae (Henriquez and Spence 1993, record for Group C).

*Lathromeroidea exemplum* Pinto,  
new species

(Figs 145, 164, 174, 181, 183, 191)

This species is one of several belonging to Section B. It was chosen for description because it is the most commonly collected

species of the group. Body length and color are based on two card-mounted specimens.

*Description.*—Body moderately slender, length 0.4 mm. Color predominantly moderately light brown. *Female.* Head broad, 0.6 as long as wide. Eyes relatively large, occupying c. 0.8 distance from top of eye to apex of clypeus; toruli placed between eyes, c. half distance from top of head to base of clypeus. Maxillary palp cylindrical, almost 3× as long as wide, with an elongate peg-like sensillum at apex c. 0.6× length of both palp and terminal seta, resp. Antenna with an elongate, narrow club, club > 2× length of scape; measurements (length/width) of scape, pedicel and club: 50/8, 26/15, 110/18; scape narrow, uniform its entire length; club outline symmetrical, in shape of a long, narrow cone. Club 5 segmented; C1 very short, transverse, closely appressed to C2, primarily visible in medial view; club widest at C2–C3; C1, C3 and C4 asymmetrical, C2 less so, C5 symmetrical, narrow, of relatively equal width entire length except at very apex; measurements (length/width) of C1–C5: 4/15, 15/21, 30/20, 37/18, 46/11. Club sensilla: BPS large, subglobose, at or near apex of all segments; C2–C5 with 1, 1, 1, 4 PLS, resp., PLS on C2 strongly curved; C2 and C3 with few APA; APB on C2 (2), C3 (1) and near apex of C5 (1); C3–C5 with several FS; C5 with 2 RS near apex and setiform UPP at apex (usually curved); longest FS c. 2.2× maximum club width. Midlobe of mesoscutum and scutellum each with 2 pair of stout, elongate setae; posterior pair on midlobe more medial in position than anterior pair. Propodeal disk slightly produced posteriorly, 2× length of metanotum; mesopleuron broad, without pleural suture. Sculpturing of mesoscutum and scutellum areolate, cells primarily longer than wide and with elevated borders, most reticulae with a series of transverse ridges within, ridges becoming longitudinal posteriorly on midlobe. Fore wing 2.2× as long as wide, venation attaining c. 0.6 FWL, fringe setae c. 0.25×



FWW; MV elongate, narrow, straight, c.  $1.7\times$  length of PM, both veins subequal in width; PM diverging from MV forming a distinct costal cell, base of PM posterior to apex of SC; SV arising from posteroapical corner of MV, elongate,  $0.4\times$  length of MV, with a distinct, narrow neck between stigma and MV; MV with 3 elongate anterior and 4 shorter posterior setae on dorsal surface, with 6 ventral setae; PM with 2 elongate setae and 2 campaniform sensilla at apex; disk moderately densely setose with most setae associated with linear setal tracks; RS1 well developed, slightly curved toward wing base and converging on Cu tracks, tracks anterior to Cu not extending to point of convergence; basal track with 2 setae; costal cell with 1–2 setae; radial process at base of PM obsolescent. Hind wing with complete anterior and medial setal tracks, posterior track consisting of a few basal setae only. Middle leg with an elongate, fine, tibial spur, spur length slightly greater than that of first tarsomere. Ovipositor relatively long, OL/HTL = 1.78 (1.5–2.0); gonoplac comprising c.  $\frac{1}{4}$  OL.

*Male.* Eyes considerably smaller than in female, occupying 0.6–0.7 distance from top of eye to apex of clypeus. Antennal club shorter than in female, length  $1.5\times$  length of scape, scape more tumid, measurements (length/width) of scape, pedicel and club: 47/14, 30/18, 68/19; C5 shorter relative to other segments than in female, subequal to C4 in length. Club sensilla similar to female except RS absent on C5 and fewer FS and APA. GC simple, rounded at base, narrowing at middle, ADA  $0.4\times$  GL, with ventral spines positioned c. half distance from base to apex; GL/HTL = 0.6.

*Types.* Holotype ♀. COSTA RICA. *Heredia*: La Selva; vii-17-1995; M08.405; in INBC. 5♀ paratypes also from La Selva as follows: 1♀, same data as holotype except 'M04.402'; 1♀, same data as holotype except without date and with label indicating 'OTS-La Selva, M05.403'; 2♀, as holotype except 'OTS-La Selva, 100 m, ix-14-

1995, Malaise trap, #02.448, Alas Project''. Paratypes deposited in BMNH, UCRC. All types are on slides. The collector is not indicated on any of the types, but all are from collections of Project ALAS at La Selva.

*Etymology.*—Exemplum (L.) = example.

*Geographic distribution.*—Known from southern Mexico S to Peru.

*Material examined.*—31♀ (29 on slides), 7♂ (all on slides). BELIZE. *Toledo*: Maya Mts., Bladen Branch Forest Res. (150 m); viii-1/15-1989, ix-3-1989; PT/MT; 4♀, 4♂; M. Williamson. COSTA RICA. *Alajuela*: Reserva Rincon Forestal, Est. Caribe (400 m), 10° 53' N, 83° 18' W; ii-19/20-2003; 1♀; J. Noyes. *Heredia*: La Selva; 7♀, 2♂ (see Types). OTS-La Selva (100 m); i-1991; YPT; 1♀; J. Noyes. *Limon*: Bribri, 7 km SW (50 m); ix/xi-1989, xii-1989/ii-1990; 2♀; P. Hanson. Guapiles, 16 km W (480 m); x/xi-1989, xii-31-1989; 2♀, 1♂; P. Hanson. *Puntarenas*: Parque Nacional Corcovado (Estación Sirena) (50 m); v/viii-1989; 1♀. R. F. Golfo Dulce (Piedras Blancas, 24 km W) (200 m); iv/v-1992, x/xi-1990; 3♀; P. Hanson. Same except: Piedras Blancas, 5 km W (100 m); xii-1990; 1♀. ECUADOR. *Napo*: Sucumbios River, Sacha Lodge, 0° 30' S, 76° 30' W; vi-18/23-1994; MT; 1♀; P. Hibbs. GUATEMALA. *Suchitepequez*: Suchitepeque, Finca Mocá Grande; ii-23/24-1995; 1♀; D. Quintero A. MEXICO. *Quintana Roo*: Nuevo X-can, 10 km S; xii-6-1993; swp. 'trail in secondary forest'; 1♀; L. Masner. PERU. *Loreto*: Teniente Lopez (220 m), 20° 36' S, 76° 07' W; vii-22-1993; 2♀; R. Leschen. VENEZUELA. *Aragua*: Cumboto (cacao plantation) (50 m); v-13-1999; MT; 4♀; J. Garcia / R. Montilla.

*Comments.*—Section B of *Lathromeroiden* includes at least 15–20 undescribed species in the New World. *L. exemplum* females are separated from all that I am aware of by the following traits: antenna elongate and narrow, with large, subglobose BPS; sculpturing of midlobe of mesoscutum consisting of relatively large cells, usually slightly longer than wide, with transverse ridges within (Fig. 183); ovipositor moderately long (OL/HTL =  $1.5\text{--}2.0\times$ ) extending only slightly beyond the apex of the metasoma. Sculpture pattern is a convenient feature for identifying slide-mounted specimens of *L. exemplum*. The few other known species

with a similar pattern are separated by BPS shape (narrow, subfusiform) or a much longer ovipositor ( $\geq 3 \times$  HTL). The species with the longer ovipositor also has a proportionately longer gonoplac. In *L. exemplum* the gonoplac is a fourth the length of the entire ovipositor; in the other species it is a little over half its length. I am not convinced I can separate males of *L. exemplum* from those of the latter species. The description of the male in the species description is based on two specimens belonging to the same series as the female types. The Material examined section only includes males collected with identifiable females.

*Lathromeroidea gerriphaga* Pinto,  
new species

(Figs 77, 146, 165, 166, 180, 196, 248, 261)

As indicated below there are at least three species in Section C of *Lathromeroidea*. The species described was chosen because it has been the subject of a detailed behavioral study by Henriquez and Spence (1993). In that paper, *L. gerriphaga* was referred to as *Lathromeroidea* sp. nov.

**Description.**—Body moderately elongate, length 0.7–0.8 mm. Color primarily dark brown with antenna and lateral areas of mesosoma distinctly lighter brown, legs primarily yellow to yellow brown except fore and hind coxae light brown, middle legs entirely yellowish. Surface shiny, very heavily sclerotized throughout, with the following areas on head and mesosoma distinctly alveolate: head posteriorly and below anterior ocellus, pronotum, lateral areas of mesosoma including axillar and axillular surfaces, propodeum, and coxae; these areas contrast with the relatively alutaceous mesoscutum and scutellum; metanotum somewhat transitional between the smoother scutellum and alveolate propodeum; metasoma smooth, shiny, except metasomal tergum II weakly alveolate anteriorly. Head excavated between eyes with a deep preocellar pit immediate-

ly in front of anterior ocellus, diameter of pit c.  $1/6$  that of ocellus.

**Female.** Eyes large, occupying more than 0.90 distance from top of eye to apex of clypeus (Fig. 165). Antenna relatively short, with length/width of scape, pedicel and club: 70/16, 35/17, 67/23; scape widest at basal half, tapering to c. half maximum width at apex; pedicel relatively elongate, anellar segments distinct, A1 slightly wider than A2; club widest at C3, subfusiform, segments all distinct and only slightly asymmetrical, all segments except subconical C5 at least slightly wider than long; length/width of C1–C5: 11/15, 20/21, 14/24, 20/22, 20/18. Club sensilla: relatively elongate APA and a few FS on all segments; C2–C5 with 1, 1, 2, 4 PLS, resp.; C5 with 2 RS near apex; UPP not visible; BCP at apex of segments narrow, subclavate. Midlobe of mesoscutum and scutellum each with two pair of elongate, relatively fine setae. Propodeal disk slightly produced and inclined posteriorly, length c. twice that of metanotum. Fore wing  $2.5 \times$  as long as wide, venation attaining 0.4–0.5 FWL, fringe setae c.  $0.3 \times$  FWW; venation straight, both PM and MV immediately adjacent to anterior margin of wing, only SC placed slightly behind margin; SC and PM confluent, PM and MV slightly disjunct; MV widening gradually and slightly from base to apex, c.  $1.2 \times$  length of PM; PM subequal in width to basal portion of MV; SV present but relatively short, subsessile to MV, with only a slight constriction at base of stigma, its length subequal to apical width of MV; MV with three elongate anterior and c. 6 shorter posterior setae dorsally, and 6–7 setae ventrally; PM with two dorsal setae and two campaniform sensilla at apex; all venation setae fine; disk densely setose with distinct linear setal tracks obvious only in relatively narrow anterior and posterior section, remainder of wing with exceptionally dense setation, area posterior to venation without setation except three in basal vein track and one or two additional

setae between retinaculum and venation. Hindwing narrow, anterior and middle setal tracks complete, a posterior track present only apically. Middle leg with an elongate fine, tibial spur, its length slightly greater than that of first tarsomere. Metasomal tergum II elongate, almost as long as remaining segments combined, with a clear oval bulla in anterolateral corners. Ovipositor moderately long,  $OL/HTL = 0.8-0.9$  ( $N=3$ ).

*Male.* Eyes much smaller than in female, occupying less than 0.7 the distance from top of eye to apex of clypeus (cf. Figs 165, 166). Antenna without RS on C5 and only 1 and 2 PLS on C4 and C5, resp. GC (Fig. 248) with length  $0.4 \times HTL$  ( $N=2$ ), c. twice as wide at base as apically, rather abruptly narrowing at basal 0.4, basal margin transverse and distinctly flanged laterally; ADA extending c. half length of capsule; a pair of stout ventral setae positioned 0.6 distance from base to apex of GC.

*Types.*—Holotype ♀, allotype ♂. CANADA. *Alberta*: nr. Dunstable, Kirchner's Pond; ix-4-1990; ex *Limnporus dissortis* Drake and Harris (Gerridae) eggs; N. H. Moreno, collr.; deposited in CNC. Thirteen paratypes (10♀, 3♂) with same data, deposited in CNC, UCRC.

The type material of *L. gerriphaga* comes from collections used by Henriquez and Spence (1993) for their study. In that paper they provide greater precision for the type locality than indicated on the collection labels: "Kirchner's East Pond, located c. 100 km NW (114° 06'W, 53° 57'N) of Edmonton, Alberta".

*Etymology.*—The name *gerriphaga* is based on Gerridae eggs being the recorded host of the species.

*Geographic distribution.* Alberta, Canada and southeastern United States.

*Material examined.*—15♀, 4♂ (all except 5♀ on slides). CANADA. *Alberta*: nr. Dunstable; 11♀, 4♂ (see Types). UNITED STATES. *Florida*: Green Swamp (Lake Co.); vii-30-1987; MT; 1♀; V. Gupta. Archbold Biological Station (Highlands Co.); vii-15/ix-1-1987; 1♀; D. Wahl. *Georgia*:

Sapelo Island, Saranna; vi-28/v-19-1987; FIT; 1♀; BRC Hym. Team. *South Carolina*: Clemson, Cherry's Crossing (Pickens Co.); ix-6/13-1987; 1♂; J. Johnson.

*Comments.*—There are at least two additional species in Group C of *Lathromeroidea*. Another species from the United States (southeastern states) and Canada (Ontario and Quebec) is similar to *L. gerriphaga* but can be distinguished by color. In that species the mesosoma is dark brown throughout, not distinctly lighter laterally. Also its legs are brown, not yellowish as in *L. gerriphaga*. The fore wing provides an additional difference. In the undescribed species the premarginal vein is slightly shorter and placed slightly posterior to the anterior wing margin forming a narrow and setose costal cell. In *L. gerriphaga* the premarginal vein coincides with the anterior wing margin its entire length. A third species occurs in Central America and northern South America. This species is easily distinguished from both of the above. Its fore wing disk is densely setose throughout (setal tracks not distinct anywhere on disk), its hindwing is also densely setose and without obvious linear setal tracks, and the stigmal vein is much shorter and sessile to the marginal vein, similar to the condition in *Aphelinoidea*. In addition, the male genitalia of this species are attenuate and narrowest at its very base, whereas in both North American species the genital capsule is broadest at the base (as in Fig. 248).

### 33. *Monorthochaeta* Blood

*Monorthochaeta* Blood 1923. Type species: *Monorthochaeta nigra* Blood, by monotypy. Blood and Kryger 1928 (redescription).

*Diagnosis.*—*Female.* Antenna with 2 anelli, 2 funicular and 3 club segments; funicular segments subequal in length and width, closely appressed; club relatively narrow, elongate, slightly narrower than funicle; all postannellar segments except F1 with at least 1 PLS. Fore wing c.



2.4× as long as wide; venation with well developed SV, a radial process present; disk densely setose, linear setal tracks not clearly distinguished from surrounding setae, RS1 absent. Legs with first tarsomere longer than others.

*Male.* Wingless (*M. uigra*) or winged as in female (*M. galatica* Nowicki). Antenna club 2 (*M. uigra*) or 3 segmented (*M. galatica*). GC (*M. uigra*) with PAR absent, VS present and asymmetrical; apodemes of AAD present.

*Distribution.*—Primarily Palearctic. A single specimen is known from the Nearctic (Canada).

*Diversity.*—Two species of *Monorthochaeta*, *M. niger* and *M. galatica* Nowicki, are known from the Palearctic (Nowicki 1940). The unique specimen from the New World, a female, cannot be separated from *M. niger*. Without males, however, its identity remains questionable. The South American species (*platensis* De Santis) assigned to *Monorthochaeta* by Doutt and Viggiani (1968) is now placed in *Burksiella* (see above).

*Discussion.*—In the New World, *Monorthochaeta* is most likely confused with *Ufeus*. Females of both have similar antennal structure but are separated by the fore wing. In *Ufeus* the wing is considerably broader and has distinct linear setal tracks including an RS1. Males of *Ufeus* are further separated by the four-segmented club. The separation of *Monorthochaeta* and *Densufens*, described from China, requires further study. Lin (1994) placed *Densufens* close to *Monorthochaeta* but separated it by the three-segmented club in males. Although the club is two segmented in males of *M. niger*, it also is three segmented in *M. galatica* (Nowicki 1940). I have not examined *M. galatica* and have no opinion as to whether it is congeneric with the type species of *Densufens*. However, it is clear that the two nominal genera cannot be separated as currently defined.

The single New World record of *Monorthochaeta* was discovered too late to allow figures. However, males and females of the genus are well illustrated in the literature

(Nowicki 1940, Doutt and Viggiani 1968, Viggiani 1971).

*New World record.*—**Canada:** Ontario (Ancaster).

*Hosts.*—Coleoptera: Chrysomelidae (Labeyrie 1962).

### 34. *Nicolavespa* Pinto (Figs 11, 51, 128, 232, 233)

*Nicolavespa* Pinto 2005. Type species: *Nicolavespa theresae* Pinto, by original designation.

*Diagnosis.*—*Female.* Antenna with 2 anelli, 2 funicular and 3 club segments; F1 short, transverse, closely appressed to F2; F2 more elongate, subcylindrical; club with a distinct terminal process. Fore tibia without spines on dorsal surface. Fore wing moderately broad, usually slightly less than twice as long as wide, venation with SV well defined; disk moderately densely setose with distinct setal tracks including RS1.

*Male.* Antennal club without an apical process. GC with VS, ventral setae and aedeagal AAP present, PAR apparently absent.

*Distribution.*—United States S to Central America.

*Diversity.*—*Nicolavespa* contains two species, the widespread *N. theresae* and *N. luiseno* Pinto, restricted to southern California.

*Discussion.*—*Nicolavespa* is the only known genus of Trichogrammatidae having a two-segmented funicle and a female club with a distinct terminal process. Superficially *Nicolavespa* resembles *Chaetostricha*. Body shape is similar in both as is antennal segmentation and general structure of the fore wing (Pinto 2005). Unlike *Nicolavespa*, however, *Chaetostricha* lacks a terminal process, the fore tibia has a prominent thornlike spine on its dorsal surface, and its genitalia lack aedeagal apodemes as well as volsellae. *Nicolavespa* may be more closely related to *Lathromeris*. Although the antenna of *Lathromeris* lacks a funicle and has a five segmented club, a terminal process is present in females.

Also, as in *Nicolavespa*, the male genitalia have aedeagal apodemes. Other details of the genitalia are not similar however, in that parameres but apparently not volsellae occur in *Lathromeris*.

**Records.**—**Costa Rica. Guatemala. Mexico:** Chiapas, Guerrero, Jalisco, Morelos, Sinaloa. **United States.** Arizona, California, Georgia, Illinois, Maryland, Oklahoma, South Carolina, Texas. **West Indies.** See Pinto (2005) for detailed collection records.

35. *Pintoa Viggiani*  
(Figs 52, 129, 184, 185)

*Pintoa* Viggiani 1989. Type species: *Pintoa nearctica* Viggiani, by original designation.

**Diagnosis.**—**Female.** Antenna elongate, with 1 anellus, 1 funicular and 3 club segments; C1 partially fused to C2, F1 with a strongly curved J-shaped PLS; BPS narrow, apically attenuate. Eyes reddish. Midlobe of mesoscutum with 1 or 2 pair of elongate setae; scutellum with a lateral and medial pair of setae, lateral pair small to minute. Fore wing narrow, 3.0–3.5× as long as wide, fringe elongate >0.5× FWW; venation elongate, attaining 0.6 FWL, SV distinct; disk moderately densely setose, linear setal tracks present but not always distinct, RS1 absent.

**Male.** Antenna more elongate than in female, C1 not partially fused to C2; club segments each with a basal whorl of extremely elongate, erect FS. GC short, tubular, enlarged basally, with a relatively large ADA, VS and PAR absent, ventral setae present; aedeagal AAP present.

**Distribution.**—Known only from the New World (Canada to Argentina).

**Diversity.**—One species, *P. nearctica*, is described. Its distribution spans that of the genus. A second, undescribed, species occurs from Florida to Ecuador. It is known from females only.

**Discussion.**—*Pintoa* is not clearly related to any other trichogrammatid genus. Greatest phenetic resemblance is with *Oligosita*. In both, the body is relatively

slender, the antenna has a single funicle and a three-segmented club, the fore wing is narrow with straight, elongate venation and it lacks distinct linear setal tracks. *Pintoa* is separated from *Oligosita* and all other Oligositini by the reddish eyes (black in oligositines), the presence of the J-shaped PLS on the funicle, two pair of setae on the scutellum (one pair in oligositines), and male genitalia (ADA much reduced and apodemes absent in oligositines). The type species is well illustrated by Viggiani (1989).

Among other differences, the two pair of elongate setae on the mesoscutal midlobe will distinguish the undescribed species of *Pintoa* from *P. nearctica* which has only a single pair.

**Records.**—**Argentina:** La Rioja. **Belize. Canada:** Ontario, Quebec. **Colombia. Costa Rica. Ecuador. Guatemala. Mexico:** Morelos, Nuevo Leon, Sinaloa Tamaulipas, Quintana Roo. **United States:** Arizona, California, Florida, Georgia, Louisiana, Maryland, Missouri, North Carolina, South Carolina, Oklahoma, South Carolina, Texas, Virginia. **West Indies.**

**Hosts.**—Unknown.

36. *Pseuduscana* Pinto, new genus  
(Figs 53, 54, 130, 234, 235)

**Type species.**—*Pseuduscana sola* Pinto, n. sp.

**Description.**—Small, length between 0.3–0.4 mm; color brown with varying degrees of white on mesosoma. **Female.** Antenna with 1 anellus and 4 club segments. Club subconical, narrow and elongate; segments relatively symmetrical; C1 short, transverse, more than twice as wide as long, only c. 1/3 length of C2; C2 about as long as wide, not tapering to apex; C3 subequal in length to C2, tapering slightly to apex; C4 much narrower, c. twice as long as wide; C1–C3 of similar width, C2–C4 of similar length; all club segments with conspicuous, large, subglobose BPS at apex; C2 with a ring of elongate FS at base; C3 with a basal and an apical ring of FS. Maxillary palp 1 segmented. Midlobe of mesoscutum usually with

only 1 pair of setae; scutellum with 2 pair but anterior pair shorter than posterior pair. Fore wing as in *Uscana* except narrower and with longer fringe setae (length  $0.2\text{--}0.3\times$  FWW), also less densely setose with setal tracks including RS1 more conspicuous. Hind wing with only an anterior and medial setal track. Ovipositor short, shorter than hind tibia; hypopygium present, of varying length.

*Male.* Antenna with only a single ring of FS on C3. GC with ADG completely consolidated into GC but otherwise exceedingly variable (shape of GC, size of ADA, presence or absence of PAR and VS, and their expression when present vary); ventral setae absent.

*Etymology.*—Name based on similarity of the new genus to *Uscana*; gender feminine.

*Distribution.*—Worldwide. In the New World, from Canada to Argentina.

*Diversity.*—Based on male genitalia, I am able to discern about 20 species of *Pseuduscana* in the New World; two of these occur in the United States. Only one species, *P. sola*, is described below. The greatest genitalic and presumably species diversity occurs in the New World. The few extralimital males examined do not differ from one another appreciably; all have simple genitalia without volsellae and parameres.

*Discussion.*—*Pseuduscana* can only be confused with *Uscana* and *Brachista* from which it differs primarily in details of the antennal club. In *Pseuduscana* C1 is much wider than long and considerably shorter than C2, C1 also lacks PLS, and all club segments have large conspicuous BCP sensilla. In *Uscana* and *Brachista*, C1 is as long or longer than C2 and, in females at least, always bears at least one PLS. Although BPS sensilla are present in these two genera they are considerably smaller and less conspicuous (cf. Figs 53, 61). In addition, most *Uscana* and *Brachista* are almost uniformly brown in color; most *Pseuduscana* are distinctly bicolored, brown with a considerable amount of white on the

mesosoma including much of the legs. Certain Chinese species of *Uscana* have relatively narrow fore wings with longer than typical fringe setae and in this way resemble *Pseuduscana*. Based on their descriptions, however, characteristics of C1 are as in other *Uscana* (Lin 1994). Color pattern and general body shape are similar in some species of *Haeckeliania* but the latter is separated by numerous features including its five-segmented club and two-segmented maxillary palp.

*Pseuduscana* is distributed worldwide but greatest known diversity is in the New World. External morphology of all species is exceptionally homogeneous; yet the male genitalia are more variable than in any other genus of Trichogrammatidae that I am aware of except perhaps *Ufens*. In some, the genitalia are simple, consisting of nothing more than a simple tubular capsule (as in Figs 242, 243). In most, however, parameres and volsellae are present (as in Fig. 235) and their conformation takes on a large number of possibilities. The shape of the capsule and size of the ADA also vary considerably. As in *Ufens* and *Trichogramma* the taxonomy of this genus will depend almost entirely on males.

*New World records.*—**Argentina:** Chaco, Formosa, Misiones, Salta. **Belize.** **Bolivia.** **Brazil:** Mato Grosso, Rondonia, São Paulo. **Canada:** British Columbia, Ontario, Quebec. **Colombia.** **Costa Rica.** **Ecuador.** **Guatemala.** **Mexico:** Chiapas, Quintana Roo, Tamaulipas. **United States:** California, Florida, Georgia, Maryland, Missouri, North Carolina, Oklahoma, South Carolina, Texas, Virginia. **Venezuela.** **West Indies.** See description of *P. sola* for specific localities of that species.

#### *Pseuduscana sola* Pinto, new species

*Description.*—Small, body length  $0.35\text{--}0.40$  mm. Color distinctly bicolored, with metasoma, pronotum and hind legs brown, mesosoma including fore and middle legs white, head and antennae light brown.



*Male.* Mandible tridentate with 2 strong sickle-shaped posterior teeth and 1 shorter, more blunt anterior tooth. Maxillary palp subcylindrical, c.  $2\times$  as long as wide, apex with terminal seta c.  $2\times$  length of segment, and a narrow, digitiform sensillum c. 0.4 segment length. Antenna with length/width of scape, pedicel and club: 32/10, 22/13, 57/13; club narrow, subfusiform with C2 slightly wider than C1 and C3, tapering evenly to apex; measurements (length/width) of club segments (C1–C4): 6/11, 20/14, 21/12, 20/8, C2–C4 moderately asymmetrical. Club sensilla: C1 – APB, 1 BPS, 1–2 APA; C2 – 1 PLS, 3 BPS, 2 FS; C3 – 1 PLS, 1 BPS, 4 FS; C4 – 2 PLS, 1 BPS, 1 FS, with PLS extending slightly beyond apex of club.

Midlobe of mesoscutum with 1 pair of elongate setae laterally at anterior fifth. Scutellum with 2 pair of setae, anterior pair c. half length of posterior pair, posterior pair shorter and less robust than mesoscutal setae; sculpturing on both structures consisting of relatively large cells without obvious corrugations within, cells variable in shape, most longer than wide. Propodial disk not produced posteriorly, subequal in length to metanotum. Fore wing  $2.1\times$  as long as wide, venation attaining 0.5 FWL, fringe setae elongate,  $0.5\times$  FWW; MV elongate, straight,  $1.5\times$  length of PM, both veins subequal in width; PM diverging only slightly from MV, with 2 setae and 2 campaniform sensilla at apex; SV elongate, c. half length of MV, arising from posteroapical corner of MV, with a distinct constriction basal to stigma; MV with 3 elongate setae anteriorly and 1–3 setae posteriorly (only 1 in holotype); disk moderately densely setose, with almost all setae associated with linear tracks; RS1 present, straight; basal track with 2 setae; usually only 1 seta at apex of narrow costal cell; radial process present but weakly indicated. GC relatively large, GL 0.7–0.8 HTL, dorsal outline of genital capsule somewhat paddle shaped,  $0.3\times$  as wide as long, narrowest aspect at apex c.  $0.3\times$

greatest width; entire apex of genitalia strongly curved ventrally; ADA large, occupying  $0.65\times$  length and  $0.75\times$  width of capsule; PAR and VS well developed; VS elongate, digitiform, adjacent, arising in basal half of GC (c. 0.4 distance from base), their length c. half GL, asymmetrically tapering to a point at apex, reaching apical 0.9 of GC; PAR shorter, also attenuate at apex, attaining apical 0.8 of GC.

*Female.* As male except antennal club with more and longer FS, 2 whorls of FS on C3, longest FS  $2.8\times$  ( $N=2$ ) greatest antennal width. Ovipositor very short, confined to apex of metasoma, OL/HTL = 0.60 ( $N=2$ ).

*Type.*—Holotype ♂: UNITED STATES. Maryland: Port Republic (Calvert Co.); viii/ix-1986; FIT; Sharkey/Munroe; in CNC.

*Etymology.*—Sola (L.), sole or only.

*Geographic distribution.*—Southeastern United States and Argentina.

*Material examined.*—3♀, 4♂ (all on slides). ARGENTINA. Misiones: Parque Nac. Iguazu, Pto. Canoas (200 m); xii-8-1990/I-6-1991; 'hill forest'; 1♀, 1♂; S./J. Peck. UNITED STATES. Georgia: Calhoun (Gordon Co.) (285 m); 34° 29' 09" N, 84° 54' 22" W; v-16-2002; 1♂; D. Yanega. Sapelo Island; vi-29/vii-18; 1987; 'live oak forest'; 1♂; BRC Hym. Team. Maryland: Port Republic; 1♂ (see Type). Prince Frederick, 7 km S; v-7/vii-7-1987; FIT, 'hardwood forest'; 2♀; BRC Hym. Team. Texas: College Station, Lick Creek Park; x-11/18-1987; MT; 1♂; R. Wharton.

*Comments.*—As indicated, *Pseuduscana* is a large but homogeneous group. Although diversity of male genitalia is extensive, other characters vary minimally. At least one other form, occurring in Argentina (Misiones) and Mexico (Chiapas), has male genitalia similar to *P. sola*. These may be conspecific but are not treated as such because of minor differences in sculpturing. In *P. sola* the mesoscutal and scutellar reticulæ are relatively smooth within; in the similar form, the reticulæ are longitudinally and transversely corrugated within.

Because of considerable morphological homogeneity except for male genitalia, females of *Pseuduscana* are not easily

distinguished. In this respect the genus very much resembles *Trichogramma* and *Ufens*, two other genera with exceptionally diverse male genitalia. Females included in the Material examined section either were collected with males and/or have no obvious structural differences from males of *P. sola*. Unfortunately, most of the specimens collected of this genus are females. Based on the relatively few males available only two species can be recognized in the United States, *P. sola* and an undescribed species with very simple genitalia lacking both volsellae and parameres. The latter also occurs in the Southeast and may be sympatric with *P. sola*. The above description of females is based on two specimens from near Prince Frederick, MD, close to the type locality.

### 37. *Pteranomalogramma* Viggiani and Velasquez

*Pteranomalogramma* Viggiani and Velasquez, 2004. Type species: *Pteranomalogramma singulare* Viggiani and Velasquez, by original designation.

**Diagnosis.**—*Female*. Antenna with 2 anelli, 2 funicular and 3 club segments; funicle subglobose, F1 very short, closely appressed to F2, F2 with PLS. Maxillary palp 1 segmented. Midlobe of mesoscutum and scutellum each with 2 pair of very short setae. Fore tibia with dorsal margin bearing 4–5 spines at apex; all tibiae robust. Fore wing unique, almond shaped, apical margin pointed; disk with area behind venation fumate and without setae, setae arranged in linear tracks in area apical to venation, RS1 absent; fringe setae elongate, length  $>0.5 \times$  FWW; venation with SV distinct, constricted between stigma and MV, slanted diagonally away from MV. Ovipositor very short.

**Male.**—Unknown.

**Distribution.**—Known only from Venezuela.

**Diversity.**—Monotypic.

**Discussion.**—*Pteranomalogramma* is known from a single female. The almond-shaped

fore wing coupled with antennal structure separates it from all other New World genera. The spinose fore tibia also is unique. The fore tibia of certain genera such as *Chaetostricha* and *Zaga* also are spinose but in these taxa the spines are placed at the middle or along the entire dorsal surface (Figs 176–178), not clustered apically as in *Pteranomalogramma*. Because males are unknown, placement of this genus in the Chaetostrichini is based solely on the antennal structure (first postanellar segment very short, closely appressed to second) which characterizes several genera in this tribe.

I became aware of *Pteranomalogramma* as this work was nearing completion and have not had the opportunity to examine the type species. Its treatment is based solely on the original description and associated figures (Viggiani and Velasquez 2004).

**Records.**—Venezuela (Aragua: Choroní).

**Hosts.**—Unknown.

### 38. *Pteryogramma* Perkins (Figs 55, 94–96, 131)

*Pteryogramma* Perkins, 1906. Type species: *Pteryogramma acuminata* Perkins, by monotypy.

*Abbelloides* Brèthes 1928. Type species: *Abbelloides marquesi* Brèthes, by monotypy. Doutt and Viggiani 1968. De Santis (1970, as synonym).

**Diagnosis.**—*Female*. Antenna with 2 anelli and 5 club segments; C1 longer than C2; C2 transverse, shortest segment of club, only club segment without a PLS. Propodeal disk subtriangular, distinctly longer than metanotum. Fore wing 1.9–2.3 $\times$  as long as wide, fringe setae of variable length; venation in most New World species with MV evenly curved at apex to form SV; disk sparsely to moderately densely setose, with most setae arranged in linear tracks, RS1 present, membrane immediately apical to RS1 usually subglabrous, area posterior to MV with foliate sensilla ventrally. Hind wing disk usually with only a middle row of setae.

**Male.** GC with a pair of very short, bilobed structures lateroventrally near apex (parameres?), ventral setae present; aedeagal AAP present.

**Distribution.**—Australia, Asia and in the New World, the West Indies, Mexico, and South America.

**Diversity.**—*Pterygogramma* includes 12 species. The genus is primarily Australasian. Three species are described from the New World: *P. marquesi* (Brèthes) from Brazil, *P. pallidipes* (Girault) from the West Indies, and *P. membraciphagum* Viggiani from Argentina and Brazil. The types of all three were examined. A few undescribed species are in collections. The genus is uncommonly collected in the New World.

**Discussion.**—*Pterygogramma* appears to be most closely related to the Australian genera *Thoreauia* and *Paruscanoidea*. The Japanese genus *Neolathromera*, although virtually unknown, may also be related based on its antennal structure. In the New World however, *Pterygogramma* is most likely confused with *Lathromeroidea*. Body structure is similar in both, wings are of similar dimension, and they share a five-segmented club. Unlike *Pterygogramma*, however, C2 is considerably longer than C1 in *Lathromeroidea*, not much shorter.

Most New World species of *Pterygogramma* differ from congeners in venation structure. In Australasian species the marginal vein ends abruptly rather than curving onto the stigmal vein. The South American species *P. marquesi* is unique from all other species in that the premarginal and marginal veins are confluent, the midlobe of the mesoscutum has three pair of setae, and the scutellum is extremely setose with six pair of setae (Fig. 95). I am unaware of any other trichogrammatid with more than two pair of scutellar setae. *P. marquesi* also differs from most congeners in having a more setose hind wing; its male genitalia, however, are typical for the genus (Fig. 96).

**New World records.**—**Argentina:** Salta.  
**Brazil:** Rio de Janeiro, Santa Catarina.

**Bolivia. Ecuador. Guatemala. Panama. Mexico:** Quintana Roo. **West Indies.**

**Hosts.**—Hemiptera: Aetalionidae (Brèthes 1928), Cicadellidae (Perkins 1906).

### 39. *Tumidiclava* Girault (Figs 10, 56, 57, 132, 236, 237)

*Tumidiclava* Girault 1911. Type species: *Tumidiclava pulchrinotum* Girault, by original designation.

*Orthoneura* Blood 1923. Type species: *Orthoneura bimaculata* Blood, by monotypy. Blood and Kryger 1928 (redescription).

*Orthoneurella* Blood and Kryger 1929 (*n. n.* for *Orthoneura* Blood 1923, *nec* Macquart 1829).

**Diagnosis.**—**Female.** Antenna with 2 anelli and a suboval club of 2–3 segments; club with an elongate terminal process at apex. Fore wing moderately wide, slightly more than twice as long as wide; venation similar to *Aphelinoidea*, relatively short (extending to c. 0.4 FWL) with stigma broad and very short, sessile to MV, MV with only 3 anterior setae on dorsal surface, posterior setae absent; disk usually moderately densely setose, R, RS2 and Cu2 usually distinguishable, remainder of surface with setae scattered and not arranged in linear tracks. Hind wing with complete anterior and middle setal tracks, posterior track usually absent or incomplete. Hypopygium well developed, with a relatively narrow posterior prolongation.

**Male.** Antennal club with 2–5 segments, terminal process absent. Metasomal tergum VII with a pair of lateral suboval or reniform pustules posterior to spiracles, tergum VI with or without similar structures. GC truncate or emarginate basally, PAR present but usually reduced, VS absent; aedeagal AAP present.

**Distribution.**—Worldwide. Known to occur from Canada to Argentina in the New World. Uncommonly collected in the tropics.

**Diversity.**—There are 18 species of *Tumidiclava* described. Only two occur in the New World. *T. pulchrinotum* is broadly distributed in North America, and *T.*



*pampeana* De Santis occurs in Argentina. There are a modest number of undescribed species.

**Discussion.**—*Tumidiclava* is superficially similar to *Aphelinoidea*. Characteristics of the fore wing, antenna and male genitalia are similar. In both, a funicle is absent, the fore wing is only moderately wide, the stigma is sessile to the marginal vein and the fore wing discal setation is relatively dense and not uniformly arranged in linear tracks. The presence of the terminal process on the club of *Tumidiclava* females and the pustulate metasomal tergum VII in *Tumidiclava* males separate these genera. They also are distinguished by differences of the fore and hind wings (Pinto 1997a).

It is likely that *Tumidiclava* is more closely related to *Lathromeris*. Although fore wing structure does not suggest this, females of both have a terminal process on the antennal club, and the males have similar metasomal modifications (as in Fig. 264). Male genitalia and hypopygial structure are similar in both groups also (see *Lathromeris*).

Although most *Tumidiclava* are characterized by the moderately densely setose fore wing, I have examined undescribed forms with relatively sparse discal setae; in one species from Turkmenistan the disk is almost glabrous.

**New World records.**—**Argentina:** Formosa, Jujuy, La Pampa, La Rioja, Salta. **Belize.** **Canada:** Alberta, British Columbia, Prince Edward Island, Ontario, Quebec, Saskatchewan. **Costa Rica.** **Chile.** Region VIII. **Ecuador.** **Guatemala.** **Mexico:** Guerrero, Jalisco, Nuevo Leon, San Luis Potosi, Tamaulipas. **United States:** Arizona, Colorado, Florida, Georgia, Illinois, Iowa, Kansas, Maryland, Mississippi, Missouri, Montana, Nevada, New Mexico, North Carolina, Oregon, Pennsylvania, Tennessee, Texas, Utah, Virginia, Washington, Wisconsin, Wyoming. **West Indies.**

**Hosts.**—Coleoptera: Curculionidae (Yousuf and Shafee 1988). Lepidoptera: Cossi-

dae (Pan and Lim 1980), Pyralidae (Scheibelreiter 1976), Noctuidae (Scheibelreiter 1980).

#### 40. *Tumidifemur* Girault (Figs 58, 133, 134, 160)

*Tumidifemur* Girault 1911. Type species: *Tumidifemur pulchrum* Girault, by original designation.

**Diagnosis.**—**Female.** Antenna with 2 anelli and 4 somewhat asymmetrical club segments; club subconical, segments subequal in length, widest at C1 and gradually narrowing to apex, surface of C1 and C2 finely, longitudinally ridged. Fore wing moderately wide, c. twice as long as wide; venation with elongate MV, SV angling only slightly away from wing margin, directed toward wing apex, PM narrower than MV with two strong setae, MV and PM confluent or very narrowly separated, with several short stiff setae immediately anterior to PM in costal cell and/or on MV itself; disk densely setose beyond venation but often with a large glabrous area near center, generally without distinct linear setal tracks although glabrous area may result in a linear track at its basal border (resembling an RS1) (cf. Figs 133, 134), also setal tracks may be distinguishable along extreme anterior and posterior section of disk. Hind wing relatively wide, cultriform, with length of posterior fringe only slightly greater than maximum wing width. Mesotibia with apical spur elongate, fringed, as long or longer than first tarsomere.

**Male.** GC reduced, small, narrowing at base, without VS, PAR, ventral setae or aedeagal AAP; GL less than half HTL.

**Distribution.**—New World tropics and China.

**Diversity.**—Two species have been described. In the New World, *Tumidifemur* has heretofore been known only from the type series of *T. pulchrum* from Trinidad (examined, NMNH). The second named species occurs in China (see below). A few

undescribed species are known from Central and South America.

*Discussion*.—The genus is best separated by its four-segmented club and unique fore wing features (Figs 133, 134, 160). The latter include the stigmal vein slanted only slightly away from the marginal vein, the densely setose costal cell and/or marginal vein, and the densely setose disk which lacks linear setal tracks in the area apical to the venation. *Tumidifemur* is somewhat anomalous and a close relationship to other genera is not obvious. The four-segmented, subconical club, tumid femora and highly reduced male genitalia suggest a tie to *Uscana* but the latter lacks the fore wing traits defining *Tumidifemur*.

The type species of *Tumidifemur* has a patch of dense setation immediately behind the marginal vein, but this does not characterize the undescribed species. Girault (1911b) and Doutt and Viggiani (1968) characterized the club of *Tumidifemur* as three segmented. Examination of the type and all additional material shows it to be four segmented. The placement of *T. raniispinum* Lin from China in this genus is questionable. I have not examined this species but illustrations in Lin (1994) indicate a five-segmented club and genitalia with aedeagal apodemes, features not characterizing New World *Tumidifemur*.

*New world records*.—**Colombia. Costa Rica. Ecuador. Venezuela. West Indies.**

*Hosts*.—Hemiptera: Membracidae (Girault 1911b).

#### 41. *Ufens* Girault (Figs 59, 60, 135, 238)

*Ufens* Girault 1911. Type species: *Trichogramma nigrum* Ashmead, by original designation.

Because *Ufens* currently is being revised by A. K. Owen (UCRC) generic treatment is abbreviated. Omitted are the complete list of generic synonyms and specific distribution records for the genus. None of the omitted synonyms relate to New World taxa.

*Diagnosis*.—*Female*. Antenna with 2 anelli, 2 funicular and 3 club segments; F1 relatively large, subequal in width to F2, all postanellar segments with PLS and FS. Fore wing relatively wide (c.  $1.7\times$  as long as wide) with short fringe setae (length c.  $0.1\times$  FWW); venation with PM, MV and SV subequal in length, radial process present; disk moderately densely setose with linear setal tracks including RS1 distinct.

*Male*. Club with a small apical fourth segment, C4 with FS but not PLS, postanellar segments with conspicuous whorls of FS. Genitalia extremely variable but ADG never distinct from GC; aedeagal AAP absent in New World species; VS, PAR and IVP usually present and highly modified.

*Distribution*.—Worldwide except not yet recorded from South America. In the New World, *Ufens* occurs from Canada to Central America, including the West Indies.

*Diversity*.—There are 30 named species of *Ufens*. Some of these are incorrectly placed and several additions are being described (Owen, in prep.). Approximately forty-five species of *Ufens* now occur in collections. Three currently are recognized in the New World (Al-Wahaibi et al. 2005). These include *U. niger* (Ashmead), *U. ceratus* Owen, and *U. principalis* Owen. Four additional species await description (Owen, pers. comm.).

*Discussion*.—*Ufens* is most easily confused with *Mirufens*, *Zagella* and *Burksiella*. Wing structure is comparable, and, in females of all genera, antennal structure is similar as well (two-segmented funicle, three-segmented club). In addition, males of *Mirufens* have a small fourth club segment as do *Ufens* males. *Mirufens* is easily separated by its two-segmented maxillary palp, the transversely ridged pedicel and the row of spines on the fore tibia. *Zagella* and *Burksiella* are separated by funicle structure. In *Ufens* both F1 and F2 are similar in width, and each bears PLS. In *Zagella* and *Burksiella*, F1 is considerably smaller, narrower, and closely ap-

pressed to F2; it never bears PLS. Besides *Mirufens*, the only other genus with a C4 in males is *Ceratogramma*. The two-segmented palp, three anelli and absence of the setal track RS1 in *Ceratogramma* separate it from *Ufens*.

**Hosts.**—Hemiptera: Cicadellidae (Al-Wahaibi et al. 2005). Orthoptera: Tettigoniidae (Timberlake 1927).

#### 42. *Uscana* Girault

(Figs 61, 136)

*Uscana* Girault 1911. Type species: *Uscana semifumipennis* Girault, by original designation.

*Bruchoctonus* Grese 1923. Type species: *Bruchoctonus senex* Grese, presumably by monotypy (see Fursov 1988).

**Diagnosis.**—Color of mesosoma and metasoma relatively uniform, brownish. *Female*. Antenna usually with 2 anellar and 4 club segments; C1 often slightly separated from C2, as long or longer than C2 and with at least 1 PLS. Midlobe of mesoscutum and scutellum each with 2 pair of setae, both pairs on each sclerite subequal in length. Fore wing variable in shape, 1.8–2.0× as long as wide in New World species, fringe setae relatively short, < 0.2× FWW; venation with SV distinct, directed toward posterior margin of wing; disk moderately densely setose, linear setal tracks (including RS1) present but not always clearly distinguished from adjacent setae.

*Male*. Antenna with or without PLS on C1. GC highly reduced, short, without VS, PAR or ventral setae; aedeagal AAP absent.

**Distribution.**—Worldwide.

**Diversity.**—*Uscana* contains 26 species. Only three are known from the New World. Included are *U. semifumipennis* from the United States, and *U. espinae* Pintureau and Gerding and *U. chilensis* Pintureau and Gerding, from Chile. Certain species (*U. semifumipennis* in particular) have been broadly introduced for biological control of bruchid beetles (Fursov 1995b). Although widespread, *Uscana*

is not commonly collected by standard bulk sampling methods.

**Discussion.**—*Uscana* is not a very distinctive genus and superficially resembles several others. However, its four-segmented club and lack of a funicle will separate it from most. In the New World it is only likely confused with *Pseuduscana*, *Tumidifemur* and *Uscanopsis* which have a similar antennal formula. *Pseuduscana* is separated by its considerably shorter C1 which lacks a PLS; the two usually can also be separated by color (see *Pseuduscana*). *Tumidifemur* is distinguished by its densely setose fore wing which lacks setal tracks on most of the discal surface, as well the unique characters associated with its venation. The orientation of the stigmal vein should also separate *Tumidifemur*. In *Tumidifemur* it is directed toward the apical wing margin; in *Uscana* it is directed toward the posterior wing margin. The poorly known *Uscanopsis*, apparently with similar antennal structure, is separated by its exceptionally long hind tibial spur.

Yousuf and Shafee (1988) treated *Zaga* as a junior synonym of *Uscana*. This synonymy is not accepted (see *Zaga* below).

**New World records.**—**Brazil:** Santa Catarina. **Argentina:** La Rioja, Misiones. **Chile:** (see Pintureau et al. 1999). **Guatemala.** **Mexico:** Baja California Sur, Oaxaca, San Luis Potosi, Sinaloa, Tamaulipas. **United States:** Arizona, California, Georgia, Texas.

**Hosts.**—Coleoptera: Bruchidae (Fursov 1995b, Pintureau et al. 1999).

#### 43. *Uscanella* Girault

*Uscanella* Girault 1911. Type species: *Uscanella bicolor* Girault, by original designation.

**Diagnosis.**—*Female*: Antenna with 2 anellar and 3 club segments; C1 short, discoid, appressed to C2. Fore wing distinctive: moderately wide with fringe setae elongate, c. half as long as FWW, apical margin of wing arcuate; venation with an elongate, parallel sided SV (i.e. without an expanded stigma) which is directed toward the apical



margin of wing, a short postmarginal vein present; disk sparsely setose overall with few linear setal tracks, setation moderately dense anterior to r-m but subglabrous between r-m and Cu2, RS1 absent; discal setae extremely short, their sockets more apparent than the setae themselves. Femora tumid.

*Male.* Unknown.

*Distribution.*—Known only from Trinidad and Tobago.

*Discussion.*—*Uscanella* is known only from the original types (examined, NMNH). The three-segmented club, short and transverse C1, distinctive stigmal vein and the very short, relatively sparse setation on the fore wing separate it from other genera. The orientation and shape of the stigmal vein are somewhat similar in *Viggianiella*, although its length is considerably shorter in *Uscanella*; also the two are dissimilar for most other features. Fore wing structure also resembles that in *Pteranomalogramma* but the apical margin is arcuate in *Uscanella*, not pointed. Also the structure of the stigmal vein differs considerably. Because males are unknown, *Uscanella* is tentatively placed in the Chaetostrichini based on antennal structure. The genus is illustrated by Doutt and Viggiani (1968).

*Records.*—**West Indies.**

*Hosts.*—Hemiptera: Membracidae (Girault 1911b).

#### 44. *Uscanoidea* Girault

(Figs 78, 147, 182, 250)

*Uscanoidea* Girault 1911. Type species: *Uscanoidea nigriventris* Girault, by original designation.

*Gnorimogramma* De Santis 1972. Type species: *Gnorimogramma aliciae* De Santis, by original designation. **New synonymy.**

*Diagnosis.*—*Female.* Antenna with 2 anelli and 5 asymmetrical club segments, club widest at C2, C2 often loosely associated with C3, C3 without APB sensilla. Fore wing 1.6–1.9× as long as wide, fringe setae 0.1× FWW; venation extending 0.4–0.5

FWL, SV constricted at base and extending apically beyond apex of MV, MV 1.4–1.6× (uncommonly 1.2×) as long as PM and subequal in width, SV+MV/PM >1.4 (usually 1.7–2.0); disk moderately densely setose, with distinct linear setal tracks, RS1 elongate with more than 5 setae, broadly curved from apex of stigma toward base of wing where it converges on the Cu tracks. Propodeal disk length subequal to that of metanotum (Fig. 182). Fore tibia rarely spinose dorsally but if so then entire surface spinose and not with a single spine at middle more prominent than others. Ovipositor variable in length but never extending appreciably beyond apex of metasoma.

*Male.*—Antennal club segments usually less asymmetrical than in female. GC gradually narrowed to apex, rounded at base, usually without PAR, ventral setae and aedeagal AAP; GL considerably less than HTL (see Discussion).

*Distribution.*—Known from the Oriental, Nearctic and Neotropical regions. In the New World, distributed from the United States to Argentina. Uncommonly collected north of Mexico.

*Diversity.*—Twelve species are assigned to *Uscanoidea*. Included are five Chinese species [three described as *Gnorimogramma*: *U. acuminata* (Lin), *U. aduncata* (Lin) and *U. oviclavata* (Lin), **new combinations**], and seven from the New World. Six of the latter were treated by Viggiani (1992) and De Santis (1997). The New World species include *U. aliciae* (De Santis), **new combination** (from *Gnorimogramma*); *U. hastata* De Santis; *U. iperterebrata* Viggiani; *U. marilandica* (Girault); *U. nigriventris* Girault; *U. parviclavata* De Santis; *U. silvestrii* Viggiani. *U. marilandica* is North American; the remainder occur in Central and South America. As with *Burksiella* and *Lathromeroidea* there are numerous undescribed species of *Uscanoidea*, particularly in the neotropics. Placement of *U. marilandica* here is based on Viggiani (1986, 1992) and notes taken from the type (NMNH) over 15

years ago. Attempts were made to confirm generic placement for this study, however the type has been on loan for over a decade and attempts at recall by NMNH were not successful.

*Discussion.*—*Uscanoidea* is defined here as having an antennal structure similar to *Zaga* but fore wings as in *Burksiella*. Also, unlike *Zaga*, ventral spines on the genital capsule are almost always absent in *Uscanoidea*. Male and female syntypes of *U. nigriventris* (examined, NMNH) are in very poor condition but diagnostic features of the genus are visible.

*Gnorimogramma*, synonymized here with *Uscanoidea*, was compared to *Chaetostricha* by De Santis (1972) and separated by the narrower club and shorter ovipositor. It also differs from *Chaetostricha* in lacking both a distinct funicle and a single prominent spine on the fore tibia, by its wider fore wing with an arcuate RS1, and its considerably shorter genital capsule. These features place it in *Uscanoidea* as herein defined. The antennal club and ovipositor characteristics cited by De Santis to establish *Gnorimogramma* vary widely within most genera of the *Chaetostricha* group. Paratypes (UCRC) of *Gnorimogramma alliciae*, the type species, were examined.

The separation of *Uscanoidea* species from Group B of *Lathromeroidea* is not always straightforward. In a few species the wings are characteristic of the latter (narrower, longer fringe) but, as in *Uscanoidea*, the propodeum is not much, if at all, longer than the metanotum. These cannot be placed unambiguously based on current generic limits.

*Uscanoidea* also is similar to *Centrobiopsis*. It differs primarily by its broader fore wing, and shorter ovipositor and male genitalia. Unlike *Centrobiopsis*, in *Uscanoidea* the ovipositor does not extend beyond the metasoma and the genital length is considerably less than that of the hind tibia.

*New World records.*—**Argentina:** Chaco, Formosa, La Rioja, Misiones, Salta, San-

tiago del Estero. **Belize. Brazil:** Rio de Janeiro, Mato Grosso do Sul, Santa Catarina, São Paulo. **Colombia. Costa Rica. Ecuador. Guatemala. Mexico:** Chiapas, Colima, Nuevo Leon, Sinaloa, Tamaulipas, Veracruz, Yucatan. **Nicaragua. Panama. Peru. United States:** Florida, Maryland, Oklahoma, South Carolina. **West Indies.**

*Hosts.*—Hemiptera: Cercopidae (De Santis 1972), Cicadellidae (unpubl. record), Membracidae (De Santis 1997).

#### 45. *Uscanopsis* Girault

(Fig. 137)

*Uscanopsis* Girault 1916. Type species: *Uscanopsis carlylei* Girault, by original designation.

*Diagnosis.*—*Female.* Antenna apparently with a 4-segmented club (but see Discussion), club subconical, broadest at base. Propodeal disk triangular, distinctly longer than metanotum. Fore wing c.  $2.2\times$  as long as wide; venation confluent, PM c.  $3\times$  wider than MV, MV gradually curving away from wing margin to form SV, SV basal to stigma subequal in width to MV; disk moderately densely setose, all setae scattered and not arranged in linear tracks, RS1 absent. Femora tumid; tarsi short, robust, metatarsus only about half HTL; hind tibial spur unique, extremely elongate and stout, c.  $0.9\times$  length of metatarsus, dorsal surface of spur (surface facing tarsus) microsculptate.

*Male.* GC with aedeagal AAP present (presence of other genital structures questionable).

*Distribution.*—Known only from the type locality, Port of Spain, Trinidad and Tobago.

*Diversity.*—Monotypic.

*Discussion.*—*Uscanopsis* is known only from the type series of *U. carlylei* (examined, NMNH). All specimens, on a single slide, are in very poor condition and several characters cannot be adequately viewed. Girault (1916b) considered the antennal club as two segmented; Doult

and Viggiani considered it four segmented. I also detect four club segments, but there remains the possibility of a very small first segment as occurs in *Uscanoida* and other genera which, if present, is impossible to see in the types. Fortunately, the identification of *Uscanopsis* is assured by the very long and stout hind tibial spur which has no counterpart in the family. Also fore wing structure appears to be characteristic (Fig. 137). The veins are confluent, the premarginal is considerably wider than the marginal vein, and the latter gradually curves apically to form the stigmal vein. The considerably setose wing disk without linear setal tracks also helps characterize the genus.

*Uscanopsis* is not obviously related to any other group. A wide premarginal relative to the marginal vein also occurs in *Adryas*, but as indicated by Pinto and Owen (2004), the shape of the premarginal differs in the two and this is accompanied by several other differences as well. Better preserved specimens are required before comparing *Uscanopsis* with other elements in the family.

The drawings of antenna, fore wing, maxilla, and hind leg of *Uscanopsis* in Doult and Viggiani (1968, Fig. 46) are useful for identification, however my examination of the types suggest certain corrections. In their drawing of the fore wing the marginal vein is broader than in the types. Their Fig. 46D shows the apex of the marginal as wider than the base of the stigmal vein, whereas it is equally wide. Also, I find the hind tibial spur of the male syntype to be longer than that illustrated by Doult and Viggiani (Fig. 46C). The illustration of the antenna (Fig. 46A) shows the apex of the club as deeply bifid. Although indeed the case in at least one of the syntypes, this may simply be due to shrinkage of cuticle between the two apical PLS during slide preparation.

**Records.—West Indies.**

**Hosts.—Hemiptera:** Membracidae (Girault 1916b).

#### 46. *Xiphogramma* Nowicki

(Figs 62, 138, 195, 239, 240)

*Xiphogramma* Nowicki 1940. Type species: *Xiphogramma holorhoptra* Nowicki, by original designation. Pinto 1990b (generic review, key to spp.).

**Diagnosis.—Female.** Antenna with 2 anelli, 2 funicular and 1 club segment, funicular segments similar in length and width; PLS present on funicle, numerous short and fine APB sensilla on club. Fore wing with base of MV and apex of PM poorly sclerotized, light in color, SV short, lacking a basal constriction, MV without numerous heavy setae dorsally; disk densely setose but dense setation not extending basally behind venation, linear setal tracks poorly indicated at least apically, RS1 absent. Ovipositor elongate, extending length of metasoma and with apical 0.3–0.4 reaching beyond metasomal apex.

**Distribution.—**Europe, Asia, Africa, North America.

**Diversity.—**Four species of *Xiphogramma* are described. Included are *X. annekei* Doult (Africa), *X. holorhoptra* (Europe), *X. indicum* Hayat (Asia) and *X. fuscum* Pinto (North America).

**Discussion.—**A discussion of generic limits and separation of *Xiphogramma* from the closely related *Chaetogramma* and *Brachygrammatella* is provided in the treatment of *Chaetogramma*. *Xiphogramma fuscum*, the only New World representative, is separated from *Chaetogramma* by ovipositor length. It is further separated from New World *Chaetogramma* by the completely divided funicular segments, the shape of the genital capsule (attenuate at base in *X. fuscum*, truncate basally in *Chaetogramma*), and the absence of aedeagal apodemes. These features do not separate the genus from Old World *Chaetogramma* however.

**New World records.—Canada:** Alberta. **Mexico:** Baja California Sur, Sinaloa, Sonora. **United States:** Arizona, California, New Mexico, Oregon, Texas, Utah.

**Hosts.—**Unknown.



**47. *Zaga* Girault, renewed status**  
(Figs 81–83, 149, 162, 177, 252, 253)

*Zaga* Girault 1911. Type species: *Zaga latipennis* Girault, by original designation. Yousuf and Shafee 1988 (as junior synonym of *Uscana* Girault).

*Lathrogramma* De Santis 1952. Type species: *Lathrogramma deltae* De Santis, by original designation. **New synonymy.**

**Diagnosis.**—*Female.* Antenna with 2 anelli and 5 club segments, club segments asymmetrical, C1 very short and closely appressed to C2, C2 lined longitudinally and with several PLS, C3 without APB sensilla. Fore wing broad, oblate,  $1.5\text{--}2.0\times$  as long as broad, fringe setae very short,  $< 0.1\times$  FWW (usually  $\leq 0.05$ ); venation short, not exceeding 0.5 FWL, MV short, wide, c.  $0.4\times$  as wide as long and subequal in length to and considerably wider than PM,  $SV+MV/PM < 1.5$  (usually  $< 1.3$ ); SV not constricted basally, not extending beyond apex of MV (a line drawn through SV to wing margin describes a right angle with MV); disk moderately densely setose, with distinct linear setal tracks, RS1 present and usually arranged in a straight line subperpendicular to Cu tracks, less commonly curving posteriorly toward base of wing. Fore tibiae usually with spine(s) on dorsal surface, most prominent spine near middle as in *Chaetostricha* (Fig. 177).

*Male.* GC similar to that in *Burksiella* and *Uscanoidea* but almost always with ventral setae.

**Distribution.**—Known only from Hawaii and the New World where it has been taken from Canada S to Ecuador; also present in Argentina.

**Diversity.**—Only two named species are assigned to *Zaga*, *Z. latipennis*, the type species from Virginia, and *Z. deltae* (De Santis), **new combination** (from *Lathrogramma*), from Argentina. Several undescribed species occur in North and South America.

**Discussion.**—*Zaga* is separated from similar genera by its antennal formula and fore

wing structure. It is the only genus lacking a funicle and with a five-segmented club in which the stigmal vein is not constricted basally and is oriented perpendicular to the marginal vein (Figs 149, 162). Only *Zagella*, which has a distinct funicle, has similar venation and it is likely that the two are closely related. In *Uscanoidea*, also with a five-segmented club, the marginal vein is more slender and the stigmal vein is extended apically describing an oblique angle with the marginal vein (cf. Figs 161, 162).

*Lathrogramma*, herein treated as a synonym of *Zaga*, was considered close to the Old World trichogrammatine *Ophioneuris* by De Santis (1952) based on superficial similarity in fore wing structure. The assumption that the club was only four segmented in *Zaga* (Girault 1911a, Doutt and Viggiani 1968) led to its being compared to *Uscana* rather than *Lathrogramma*. This assumption prompted Yousuf and Shafee (1988) to synonymize *Zaga* with *Uscana*. I examined types of *Zaga latipennis* (NMNH) and *Lathrogramma deltae* (paratype, UCRC) and have verified that the club is similarly five segmented in both. As in other genera of the *Chaetostricha* group, C1 is very small and sometimes difficult to discern.

*Z. latipennis* and *Z. deltae* differ considerably in size and ovipositor length. The former is among the largest of trichogrammatids with a long ovipositor spanning the entire length of the metasoma. *Z. deltae*, on the other hand, is much smaller with a considerably shorter ovipositor. The structure of the wings, antennae and male genitalia are similar in both, and differences in ovipositor length are bridged by undescribed species. Most of the undescribed species resemble *Z. deltae* more closely.

**New World records.**—**Argentina:** Buenos Aires. **Bermuda.** **Canada:** British Columbia, Ontario. **Brazil:** (R. B. Querino, pers. comm.). **Costa Rica.** **Ecuador.** **Guatemala.** **Honduras.** **Mexico:** Baja California Norte,

Baja California Sur, Chiapas, Colima, Jalisco, Morelos, Nuevo Leon, Oaxaca, Queretero, Quintana Roo, San Luis Potosi, Sinaloa, Veracruz, Yucatan. **United States:** Arizona, California, Florida, Georgia, Illinois, Kansas, Maryland, Missouri, Nevada, New Hampshire, New Mexico, North Carolina, Oklahoma, Oregon, South Carolina, Tennessee, Texas, Utah, Virginia, West Virginia, Wyoming. **West Indies.**

*Hosts.*—Unknown.

#### 48. *Zagella* Girault

(Figs 5, 84, 85, 150, 254–257, 260)

*Zagella* Girault 1918. Type species: *Paracentrobia flavipes* Girault, by original designation. Triapitsyn 2003 (lectotype designation for type species).

*Diagnosis.*—*Female.* Body usually relatively robust. Antenna with 2 anelli, 2 funicular and 3 club segments; F1 short, anelliform, closely appressed to F2, F2 slightly narrower than C1, with 1 to several PLS; club segments relatively symmetrical (i.e., segment length similar on all surfaces), C1 with APB sensilla. Fore wing broad, oblate,  $<2\times$  as long as wide, fringe setae short,  $\leq 0.1\times$  FWW; venation short, not attaining 0.5 wing length, MV short, broad,  $< 1.5\times$  length of PM and considerably wider (commonly c.  $1.5\times$  width of PM), PM and base of MV lightly sclerotized, SV not constricted at base and not extending beyond apex of MV (a line drawn through stigma to wing margin describes a right angle with MV);  $SV+MV/PMV < 1.5$  (usually c. 1.3), radial process absent; disk moderately densely setose, with distinct linear setal tracks, RS1 present and arranged in a straight line, directed toward posterior margin of wing, subperpendicular to Cu tracks, not curving posteriorly toward base of wing, commonly composed of relatively few setae (usually 5 or fewer). Fore tibia without spines on dorsal surface. Ovipositor not extending beyond metasomal apex.

*Male.* GC short, robust, its length less than HTL, with ventral setae; aedeagal

AAP absent. Genital structure variable: GC constricted at middle, without VS or PAR and with basal margin transverse in North American species (Figs 254, 255); GC with a pair of modified VS (or PAR?) and basal margin transverse or emarginate in South American species (Figs 256, 257).

*Distribution.*—Confined to the New World although not common in tropics.

*Diversity.*—Five species are placed in *Zagella*. Besides the type species, *Z. flavipes* (Girault), described from eastern United States, the only named species in the genus are from temperate South America. Included are *Z. delicata* De Santis, *Z. mimica* De Santis, *Z. nanula* De Santis, and *Z. zebrata* De Santis. Several undescribed species are known from North America especially in the Southwest. I have examined type material of all species except *Z. nanula* and *Z. mimica*; the latter two are unknown to me and placement in *Zagella* needs confirmation.

*Discussion.*—The definition of *Zagella* adopted here varies from previous treatments. Doutt and Viggiani (1968) considered *Burksiella* a junior synonym of *Zagella*. *Burksiella* is herein resurrected and certain species previously treated as *Zagella* are transferred there (see above). *Zagella* shares its distinctive fore wing venation with *Zaga*. In both the stigmal vein lacks a basal constriction and is perpendicular to the marginal vein. They also share a relatively short and broad marginal vein relative to the premarginal. The two are separated by antennal formula (two-segmented funicle, three-segmented club in *Zagella*; funicle absent, five-segmented club in *Zaga*). *Zagella* is likely confused with *Burksiella*. Characters for separation are reviewed in the treatment of the latter genus.

*Zagella* appears to have a largely bipolar distribution in the New World, occurring in North America and temperate South America. The only material I have seen from intermediate areas is a single female from Venezuela. The South American species may represent a distinct lineage.

This difference is indicated by male genitalia. In North American species the genital capsule is simple without obvious parameres or volsellae (Fig. 255) whereas the South American species examined bear a pair of laterally curved sickle-shaped structures which either represent modified parameres or volsellae (Figs 256, 257).

The species described as *Brachyia radialis* by De Santis (1997) may be a *Zagella* judging from illustrations in the original description. It clearly is not a *Brachyia*. Unfortunately the type(s) of this species can not be located (M. Loíacono, MLPA, pers. comm.). Although presumably neotropical, De Santis does not indicate a type locality for this species.

The types of *Z. flavipes* were studied by Triapitsyn (2003), who designated a lectotype. The included drawing of the male genitalia, based on one of the paralectotypes, is misleading. It shows the genital capsule as evenly tapering from base to apex and with a rounded basal margin. These features suggest *Burksiella*, the genus most easily confused with *Zagella*. I have examined the paralectotype drawn by Triapitsyn (NMNH), and although the genitalia are difficult to see well, they are typical of other North American *Zagella*, i.e., the basal margin is transverse and the capsule is constricted before the apex (as in Figs 254, 255).

**Records.**—**Argentina:** Buenos Aires, Catamarca, Chaco, Formosa, La Rioja, Mendoza, Misiones, Salta, Tucuman. **Brazil:** Minas Gerais, São Paulo. **Mexico:** Baja California Sur, Jalisco, Michoacan, Sinaloa, Sonora, Tamaulipas, Yucatan, Zacatecas. **Uruguay.** **Venezuela.** **United States:** Arizona, California, Florida, Georgia, Maryland, New Mexico, Oregon, Texas, Utah, Washington.

**Hosts.**—Hemiptera: Cicadellidae (Logarzo et al. 2004).

### Oligositini Walker

**Diagnosis.**—Eyes black. Antenna with no more than 4 postanellar segments; funicle

usually present, always 1 segmented (Figs 86–93). One pair of setae on both midlobe of mesoscutum and on scutellum (Figs 186, 187). Type 2B genitalia (Figs 258, 259): GC with ADA extremely reduced and largely directed anteriorly, VS, PAR, ventral setae and aedeagal AAP always absent.

**Discussion.**—Because the tribe was recently reviewed by Pinto and Viggiani (2004) an abbreviated treatment is presented here. They divided the group into two subtribes, Oligositina and Eteroligositina, presented a preliminary hypothesis of generic relationships and a key to the World genera.

### Oligositini: Oligositina Walker

**Diagnosis.**—Propodeal disk usually distinctly longer than metanotum at midline (Fig. 186). Mesopleuron with pleural suture (Fig. 192); transepisternal sulci absent. Metasoma with terga uniformly sclerotized their entire length. Male genitalia highly reduced to a simple tube-like structure (Fig. 258).

**Discussion.**—As noted by Pinto and Viggiani (2005), support for the monophyly of this subtribe is relatively weak.

#### 49. *Epoligosita* Girault (Figs 86, 151)

*Paroligosita* Girault and Dodd, in Girault 1915 (as subgenus of *Oligosita*). Type species: *Paroligosita biclavata* Girault and Dodd, by original designation.

*Epoligosita* Girault 1916 (as genus; *n. n.* for *Paroligosita* Girault and Dodd, *nec* Kurdjumov 1911).

*Epoligositina* Livingstone and Yacoob 1983 (as subgenus). Type species: *Epoligosita (Epoligosita) duliniae* Livingstone and Yacoob, by original designation. Lin 1990 (as genus). Pinto and Viggiani 2004 (renewed status as subgenus).

**Diagnosis.**—Antennal segmentation variable, 1 funicular segment present or absent, club 1 or 2 (rarely 3) segmented. Tarsi elongate, fore and middle tarsi distinctly longer than tibia. Propodeal disk subtended by a small subtriangular lobe. Fore



wing c. 3–4× as long as wide, widest near level of stigma; venation with PM abruptly wider than MV at junction; disk glabrous, with one or two setae at most.

*Distribution*.—The nominate subgenus is widespread. *Epoligositina* has not been recorded from the New World.

*Diversity*.—*Epoligosita* contains 22 species. Only one, *E. mexicana* Viggiani, occurs in the New World. All collections examined from North and South America either represent this species or are very similar forms.

*Discussion*.—*Epoligosita* is not easily confused with any other genus. The fore wing alone serves for identification. It is the only oligositine with a moderately narrow fore wing (3–4× as long as wide) which is essentially glabrous. Some species of *Oligosita* have a sparsely setose fore wing, but the three segmented club easily separates them from *Epoligosita*, at least in the New World. Although antennal formula is quite variable in *Epoligosita* when considering the world fauna (Pinto and Viggiani 2004), all known representatives from North and South America have a single funicle segment and a single club segment. At most the club shows a partial division into two segments.

*New World records*.—**Argentina**: Chaco, Formosa, Salta. **Costa Rica**. **Ecuador**. **Guatemala**. **Mexico**: Baja California Sur, Coahuila, Durango, Guerrero, Sinaloa. **United States**: Arizona, California, Texas. **West Indies**.

*Hosts*.—Hemiptera: Cicadellidae (Viggiani 1985, Pinto and Viggiani 1987), Tingidae (Livingstone and Yacoob 1983).

### 50. *Megaphragma* Timberlake (Figs 87, 152)

*Megaphragma* Timberlake 1923. Type species: *Megaphragma mymaripenne* Timberlake, by original designation.

*Sethosiella* Kryger 1932. Type species: *Sethosiella priesneri* Kryger, by original designation.

*Paramegaphragma* Lin 1992. Type species: *Paramegaphragma stenopterum* Lin, by original designation. Delvare 1993 (synonymy).

*Diagnosis*.—Extremely small, body length <0.3 mm.

Antenna with or without a single funicle segment, club 2 or 3 segmented, never with more than 3 postanellar segments (i.e. if club 3 segmented then funicle absent). Maxillary palp small but present. Fore wing extremely narrow, strap-shaped, c. 7× as long as wide; disk glabrous or with 1 or 2 rows of few setae. Metasomal tergum VII without spiracles.

*Distribution*.—Widespread.

*Diversity*.—Fifteen species are assigned to *Megaphragma*. Only three, *M. mymaripenne* (widespread), *M. striatum* Viggiani (Mexico) and *M. caribea* Delvare (Guadeloupe), occur in the New World.

*Discussion*.—The genus is distinguished by its very small body size, extremely narrow, strap-like fore wings, antennae with three or fewer postanellar segments, and absence of metasomal spiracles. Its closest relatives appear to be *Prestwichia* and *Sinepalpigramma* (Pinto and Viggiani 2004).

*New World records*.—**Argentina**: Buenos Aires, Formosa, Misiones, Salta. **Costa Rica**. **Mexico**: Chiapas. **United States**: California. **West Indies**.

*Hosts*.—Thysanoptera: several taxa (see Noyes 2001).

### 51. *Oligosita* Walker (Figs 88, 89, 153, 168, 172, 186, 192, 258)

*Oligosita* Walker 1851. Type species: *Oligosita collina* Walker, by monotypy.

*Westwoodella* Ashmead 1904. Type species: *Oligosita subfasciata* Westwood, by original designation.

*Paroligosita* Kurdjumov 1911. Type species: *Paroligosita bella* Kurdjumov, by original designation.

*Diagnosis*.—Antenna with 1 funicular and 3 club segments, funicle distinctly separated from club, PLS present on club. Maxillary palp present. Fore wing disk sparsely to moderately densely setose, no more than 4× as long as wide. Propodeal

disk not subtended by a small subtriangular lobe.

*Distribution*.—Worldwide.

*Diversity*.—Forty-six of the 144 species previously assigned to *Oligosita* were recently transferred to *Pseudoligosita* by Pinto and Viggiani (2004). Of the 98 species remaining in *Oligosita* only seven are from the New World. These include *O. americana* Girault, *O. clarinaculosa* (Girault), *O. sanguinea* (Girault) and *O. subfasciatipennis* (Girault) from North America; *O. desantisi* Viggiani from South America; and *O. giraulti* Crawford and *O. magnifica* Dozier from the West Indies. A large number of undescribed species undoubtedly occur.

*Discussion*.—All of the described New World *Oligosita* belong to the *collina* Group as defined by Viggiani (1976b). This assemblage is recognized and separated from congeners and all related genera by the characteristic clavate apical placoid sensillum on the antennal club of females (Figs 88, 89). This PLS resembles the terminal process in certain chaetostichine genera. In the latter, however, it is the apex of the club itself which is prolonged, not the PLS.

*New World records*.—**Argentina**: Buenos Aires, Formosa, La Rioja, Salta, Tucuman. **Belize**. **Bolivia**. **Brazil**: Amazonas, Pará, Pernambuco. **Canada**: Alberta, British Columbia, Manitoba, Ontario, Prince Edward Island. **Chile**: Región Metropolitana. **Colombia**. **Costa Rica**. **Ecuador**. **Guatemala**. **Mexico**: Baja California Sur, Campeche, Chiapas, Colima, Distrito Federal, Guerrero, Jalisco, Morelos, Nuevo Leon, Quintana Roo, Sinaloa, Tamaulipas, Veracruz, Yucatan. **Panama**. **United States**: Arizona, California, Colorado, Florida, Georgia, Iowa, Illinois, Kansas, Louisiana, Maryland, Michigan, Mississippi, Missouri, Montana, Nebraska, Nevada, New Mexico, North Carolina, Oklahoma, Oregon, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Utah, Virginia, Washington, Wisconsin, Wyoming. **Venezuela**. **West Indies**.

*Hosts*.—Hemiptera: (primarily Cicadellidae, see Noyes 2001).

## 52. *Prestwichia* Lubbock (Figs 90, 154)

*Prestwichia* Lubbock 1864. Type species: *Prestwichia aquatica* Lubbock, by monotypy.

*Austromicron* Tillyard 1926. Type species: *Austromicron zygoterorum* Tillyard, by original designation. Doutt and Viggiani 1968 (synonymy).

*Diagnosis*.—Antenna with 1 funicular and 3 club segments, funicular segment closely associated with club (club often appearing 4 segmented); antenna with PLS on surface of segments. Maxillary palp present. Fore wing narrow, c. 7× as long as wide; disk densely setose in apical half, setae not arranged in linear tracks. Metasomal tergum VII without spiracles. Males commonly wingless.

*Distribution*.—Australia, Asia, Europe, Africa and North America.

*Diversity*.—Five species of *Prestwichia* have been described. Two undetermined collections from Florida are the only records from the New World.

*Discussion*.—The narrow, highly setose fore wing and antennal structure separate *Prestwichia* from other oligositines. It is most likely confused with *Sinepalpigramma* of Central and South America. Antennal structure is superficially similar in the two genera but *Sinepalpigramma* lacks PLS on the antennal surface as well as maxillary palpi; also its fore wings are considerably wider.

*New World records*.—**United States**: Florida.

*Hosts*.—*Prestwichia* occurs in aquatic habitats where hosts of a variety of aquatic insect groups (Coleoptera, Hemiptera, Odonata) are parasitized (Fursov 1995c).

## 53. *Sinepalpigramma* Viggiani and Pinto (Figs 91, 155, 171)

*Sinepalpigramma* Viggiani and Pinto 2003. Type species: *Sinepalpigramma longiciliatum* Viggiani and Pinto, by monotypy.

**Diagnosis.**—Antenna with 1 funicular segment and a 3-segmented club, funicle closely associated with club; antenna without PLS. Maxillary palp absent. Surface of mesoscutum and scutellum smooth, without indication of reticulæ. Metasomal tergum VII without spiracles.

**Distribution.**—From northern Mexico to Argentina.

**Diversity.**—Two species of *Sinepalpigramma* have been described, the type species and *S. longiterebratum* Viggiani and Pinto. *S. longiciliatum*, is the more widespread occurring throughout the range of the genus. *S. longiterebratum* is known only from Ecuador. A possible third species occurs in Brazil (Viggiani and Pinto 2003).

**Discussion.**—The genus is easily recognized by the absence of maxillary palps. Overall antennal structure is similar to *Prestwichia* but unlike that genus the antennal surface lacks PLS; also the fore wings are considerably wider in *Sinepalpigramma*. Males have not been clearly associated.

**New World records.**—**Argentina:** Missiones. **Brazil:** Minas Gerais. **Colombia.** **Ecuador.** **Costa Rica.** **Mexico:** Michoacan, Nuevo Leon, Tamaulipas. **Panama.** **Venezuela.**

**Hosts.**—Unknown.

### Oligositini: Eteroligositina Lin

**Diagnosis.**—Propodeal disk usually only slightly longer than metanotum (Fig. 187); mesopleuron without a pleural suture (Fig. 197); transepisternal sulci present; metasoma almost always with at least anterior 3 terga longitudinally striate posteriorly (Figs 187, 197). Male genitalia more variable than in Oligositina.

**Discussion.**—Unlike the Oligositina, the monophyly of the Eteroligositina is on firmer ground (Pinto and Viggiani 2004). Six genera are assigned to this subtribe (Pinto and Viggiani 2004). Only two, *Doirania* and *Pseudoligosita*, occur in the

New World. The extralimital genera are *Chaetostrichella*, *Eteroligosita*, *Hayatia*, and *Probrachista*.

### 54. *Doirania* Waterson (Figs 92, 156)

*Doirania* Waterson 1928. Type species: *Doirania leefmansii* Waterson, by original designation. Pinto 2004 (generic review).

**Diagnosis.**—Antenna with 1 funicular and 1 club segment, funicle well separated from club, transverse. Metasoma with anterior 3 terga longitudinally striate posteriorly. Male genitalia simple, reduced to a single tube with two short apodemes at base.

**Distribution.**—North America north of Mexico; Palearctic Region, Indonesia and New Guinea. A record from Ecuador (Pinto 2004) requires confirmation.

**Diversity.**—There are three species of *Doirania*. The only New World species is *D. elegans* Pinto.

**Discussion.**—*Doirania*, as currently defined, is easily separated from other oligositine genera. The one-segmented funicle and club, the transverse funicular segment along with the longitudinally striate metasomal terga are characteristic. It is closely related to *Pseudoligosita* (Pinto and Viggiani 2004), a genus with three club segments and a usually longer funicular segment. A few species with three club segments and identifiable as *Pseudoligosita* on this basis may actually belong to *Doirania*, which would alter its definition (see Pinto 2004). These forms are known only from females and the absence of males precludes clear-cut placement at the present time. In males of *Doirania* the genitalia are extremely reduced as in the Oligositina (as in Fig. 258). In *Pseudoligosita* the base of the genitalia have distinctive posteriorly directed apodemes (Fig. 259).

**New World records.**—Occurring in the eastern United States and southeastern Canada, with a single record from Arizona. See Pinto (2004) for specific locales.



*Hosts*.—Orthoptera: Tettigoniidae (Caudwell 2000).

**55. *Pseudoligosita* Girault**  
(Figs 93, 157, 197, 259)

*Pseudoligosita* Girault 1913. Type species: *Pseudoligosita arnoldi* Girault, by original designation. Pinto and Viggiani 2004 (renewed status).

*Zorontogramma* Silvestri 1915. Type species: *Zorontogramma distinctum* Silvestri, by original designation. Douthett and Viggiani 1968 (as subgenus of *Oligosita*). Pinto and Viggiani 2004 (synonymy).

*Diagnosis*.—Distinguished from *Doirania*, the only other eteroligositine genus in the New World, by the 3-segmented club. Fore wing disk usually with a crescent-shaped fumation at apex of stigma, apex of marking directed toward base of wing. Male genitalia strongly curved ventrally with posteriorly directed apodemes at base (Fig. 259).

*Distribution*.—Worldwide.

*Diversity*.—Forty-six species were transferred from *Oligosita* to *Pseudoligosita* by Pinto and Viggiani (2004). Of these, five occur in the New World. Included are *P. cosmosipennis* (Girault), *P. marilandia* (Girault) and *P. plebia* (Perkins) from North America; and *P. fasciata* (Viggiani) and *P. longifragiata* (Viggiani) from South America. These species are not easily identifiable but it is clear that several undescribed forms remain.

*Discussion*.—Although formerly considered members of *Oligosita*, the species of *Pseudoligosita* have a closer relationship to the Old World *Chaetostrichella* and *Probrachista*. As in all Eteroligositina the anterior-most visible metasomal terga are divided into an anterior uniformly sclerotized portion and a posterior, longitudinally striate section. In the New World only *Doirania* has a similar feature. In *Doirania* the club is one segmented, and the male genitalia lack the posteriorly directed apodemes at the base.

*New World records*.—**Argentina**: Chaco, Formosa, Jujuy, La Rioja, Misiones, Salta, Tucuman. **Bolivia**. **Brazil**: Minas Gerais, Sao Paulo. **Canada**: Alberta, Manitoba, New Brunswick, Nova Scotia, Quebec. **Colombia**. **Costa Rica**. **Ecuador**. **Guatemala**. **Honduras**. **Mexico**: Baja California Norte, Baja California Sur, Campeche, Chiapas, Guerrero, Jalisco, Michoacan, Morelos, Nuevo Leon, Oaxaca, Quintana Roo, San Luis Potosi, Sinaloa, Sonora, Tamaulipas, Veracruz, Yucatan. **Panama**. **United States**: Arizona, California, Colorado, Florida, Georgia, Illinois, Kansas, Maryland, Michigan, Mississippi, Missouri, New Mexico, North Carolina, Oklahoma, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Virginia, West Virginia, Wisconsin. **Uruguay**. **Venezuela**. **West Indies**.

*Hosts*.—Hemiptera, Orthoptera, and Coleoptera (see Pinto and Viggiani 2004).

## ACKNOWLEDGMENTS

This work owes a great debt of gratitude to the collection managers and collectors who provided specimens for study. This consisted of important curated material and type specimens as well as a wealth of uncurated material gleaned from numerous bulk samples from throughout the Western Hemisphere. The following individuals and their current or former institutions are acknowledged in this regard: John Noyes (BMNH), John Huber (CNC), Gennaro Viggiani (DEZA), Robert Zuparko (CAS, EMEC), Michael Sharkey (HIC), Colin Favret (INHS), Arturo Roig-Alsina (MACN), Paul Hanson (MZCR), Marta Loiacono and the late Luis De Santis (MLPA), Terry Erwin, Michael Gates and Michael Schauf (NMNH), James Woolley (TAMU), Steve Heydon (UCDC), Jeremiah George, Gordon Gordh, John Heraty, John LaSalle, James Munro, Albert Owen, Serguei Triapitsyn, and Doug Yanega (UCRC).

Special acknowledgment is owed to Gary Platner for preparing most of the slide-mounted material used in this study, for considerable assistance with the SEM work, for plate preparation and for providing additional help in all phases of the project. Rob Velten was influential in developing the protocol used for slide mounting and also helped in curating material. Drawings were prepared by Marina Planoutene.

Financial support for this study was provided by a grant from the USDA (NRIICGP) (2001-35316-11012; J. Pinto, PI), an NSF PEET grant (BSR-9978150; J. Heraty, PI), and my department at U.C. Riverside.

# LITERATURE CITED

- Al-Wahaibi, A. K., A. K. Owen, and J. G. Morse. 2005. Description and behavioural biology of two *Ufens* species (Hymenoptera: Trichogrammatidae), egg parasitoids of *Homalodisca* species (Hemiptera: Cicadellidae) in southern California. *Bulletin of Entomological Research* 95: 275–288.
- Ashmead, W. H. 1894. A new genus and species of Proctotrypidae and a new species of *Brachysticha*, bred by Prof. F. M. Webster. *Cincinnati Society of Natural History* 17(3): 170–172.
- Ashmead, W. H. 1900. Some Hymenopterous parasites from dragon-fly eggs. *Entomological News* 11: 615–617.
- Bin, F. and P. Dessart. 1983. Cephalic pits in Proctotrupoidea, Scelionidae and Ceraphronoidea (Hymenoptera). *Redia* 66: 563–575, 10 pls.
- Blood, B. N. 1923. Notes on Trichogrammatinae taken around Bristol. *Annual Report and Proceedings of the Bristol Naturalists' Society* 5: 253–258.
- Blood, B. N. and J. P. Kryger. 1928. New genera and species of Trichogrammatidae with remarks upon the genus *Asynacta* [Hym. Trichogr.]. *Entomologiske Meddelelser* 16: 203–222.
- Brêthes, J. 1928. Descrição da vespinha *Abbeloides marquesi* Brêthes (novo genero e nova especie). *Boletim Instituto Biologico de Defesa Agricola* 6: 20–22.
- Caudwell, R. 2000. A sustainable IPM system for oil palm in Papua New guinea. *The British Crop Protection Council Conference, Pests & Diseases* 1: 215–220.
- Costa Lima, A. d.a. 1960. Sobre alguns microhimenópteros aquáticos (Chalcidoidea, Eulophidae e Trichogrammatinae). *Arquivos do Instituto Biológico, São Paulo* 27: 197–199.
- Delvare, G. 1988. *Ceratogramma etiennei* n. sp., parasite, a la Guadelupe de *Diaprepes abbreviatus* L. (Hymenoptera, Trichogrammatidae; Coleoptera, Curculionidae). *Revue Francaise d'Entomologie (n.s.)* 10: 1–4.
- Delvare, G. 1993. Sur les *Megaphragma* de Guadeloupe avec la description d'une espèce nouvelle (Hymenoptera, Trichogrammatidae). *Revue Française d'Entomologie (n.s.)* 15: 149–152.
- De Santis, L. 1952. Chalcidoideos Argentinos, nuevos y conocidos (Hymenoptera). *Revista de la Sociedad Entomológica Argentina* 15: 266–276.
- De Santis, L. 1957. Descripción de nuevos géneros y especies de Calcidoideos Argentinos. I (Hymenoptera). *Notas del Museo de la Plata, Buenos Aires (Zoología)* 19(166): 33–72.
- De Santis, L. 1970. Tricogrammatidos Neotropicales, nuevos y conocidos (Hymenoptera). *Revista del Museo de La Plata (n.s.) (Zoología)* 11: 1–19.
- De Santis, L. 1972. Nuevo genero y nueva especie de Trichogrammatidae del Brasil (Hymenoptera: Chalcidoidea). *Arquivos da Universidade Federal Rural do Rio de Janeiro* 2: 27–39.
- De Santis, L. 1981. Catalogo de los himenopteros calcidoideos de América al sur de los Estados Unidos – Primer Suplemento. *Revista Peruana de Entomologia* 24: 1–38.
- De Santis, L. 1997. Afelinidos y tricogramátidos de la colección del Dr. Alejandro A. Ogloblin (Insecta, Hymenoptera) II. Segunda Comunicación. *Sesion Ordinaria del Academia Nacional de Agronomia y Veterinaria* 51(8): 7–17.
- Doutt, R. L. 1968. The genus *Brachygrammatella* Girault (Hymenoptera: Trichogrammatidae). *The Pan-Pacific Entomologist* 44: 289–294.
- Doutt, R. L. 1974. *Chaetogramma*, a new genus of Trichogrammatidae. *The Pan-Pacific Entomologist* 50: 238–242.
- Doutt, R. L. and G. Viggiani. 1968. The classification of the Trichogrammatidae (Hymenoptera: Chalcidoidea). *Proceedings of the California Academy of Sciences (4<sup>th</sup> ser.)* 35: 477–586.
- Dozier, H. L. 1932. Descriptions of new trichogrammatid (Hymenoptera) egg parasites from the West Indies. *Proceedings of the Entomological Society of Washington* 34: 29–37.
- Fursov, V. 1988. New species of *Uscana* Girault (Hymenoptera, Trichogrammatidae) from Gruzia and the Ukraine. *Entomological Review* 67: 17–26.
- Fursov, V. 1995a. A new species of the chalcidoid genus *Szelenyia* (Hymenoptera, Trichogrammatidae) from Spain. *Journal of the Ukrainian Entomological Society* 2: 51–56. (In Ukrainian).
- Fursov, V. 1995b. A world review of *Uscana* species (Hymenoptera, Trichogrammatidae), potential biological control agents of bruchid beetles (Coleoptera, Bruchidae). *Les Colloques de l'INRA* 73: 15–17.
- Fursov, V. 1995c. A review of European Chalcidoidea (Hymenoptera) parasitizing the eggs of aquatic insects. *Irish Biogeographical Society Bulletin* 18: 2–12.
- George, J. N. 2003. A review of the Paracentrobiini (Hymenoptera: Trichogrammatidae) and a revision of the United States species of *Ittys* and *Ittysella*. *M.S. thesis, University of California, Riverside*. 124 pp.
- Gibson, G. A. P. 1997. Morphology and terminology. Chap. 2, pp. 16–44. In Gibson, G. A. P., J. T. Huber and J. B. Woolley, eds. *Annotated Keys to the Genera of Nearctic Chalcidoidea (Hymenoptera)*. NRC Research Press, Ottawa, Ontario, Canada. 794 pp.
- Girault, A. A. 1911a. Descriptions of nine new genera of the chalcidoid family Trichogrammatidae. *Transactions of the American Entomological Society* 37: 1–42.
- Girault, A. A. 1911b. Synonymic and descriptive notes on the Hymenoptera Chalcidoidea with descriptions of several new genera and species. *Archiv für Naturgeschichte* 77(suppl. 2): 119–140.

- Girault, A. A. 1911c. Synonymic and descriptive notes on the chalcidoid family Trichogrammatidae with descriptions of new species. *Transactions of the American Entomological Society* 37: 43–83.
- Girault, A. A. 1912. Australian Hymenoptera Chalcidoidea—I. The family Trichogrammatidae with descriptions of new genera and species. *Memoirs of the Queensland Museum* 1: 66–116.
- Girault, A. A. 1915. Australian Hymenoptera Chalcidoidea—I. Second Supplement. *Memoirs of the Queensland Museum* 3: 142–153.
- Girault, A. A. 1916a. Notes on North America Mymaridae and Trichogrammatidae (Hym.). *Entomological News* 27: 4–8.
- Girault, A. A. 1916b. New miscellaneous chalcidoid Hymenoptera with notes on described species. *Annals of the Entomological Society of America* 9: 291–308.
- Girault, A. A. 1916c. Descriptions of and observations on some chalcidoid Hymenoptera – II. *The Canadian Entomologist* 48: 265–268.
- Girault, A. A. 1918. North American Hymenoptera Trichogrammatidae. 11 pp. Privately printed, Sydney, Australia. [Reprinted in Gordh, G., A. S. Menke, E. C. Dahms and J. C. Hall. 1979. *Memoirs of the American Entomological Institute*, No. 28: 142–152].
- Hall, D. G., J. Peña, R. Franqui, R. Nguyen, P. Stansly, C. McCoy, S. L. Lapointe, R. C. Adair, and B. Bullock. 2001. Status of biological control by egg parasitoids of *Diaprepes abbreviatus* (Coleoptera: Curculionidae) in citrus in Florida and Puerto Rico. *BioControl* 46: 61–70.
- Hayat, M. 1981. The genera *Chaetogramma* and *Lathromeromyia* from India, with descriptions of two new species (Hymenoptera: Trichogrammatidae). *Bollettino del Laboratorio di Entomologia Agraria 'Filippo Silvestri' di Portici* 38: 73–79.
- Hayat, M. and G. Viggiani. 1984. A preliminary catalogue of the Oriental Trichogrammatidae (Hym.: Chalcidoidea). *Bollettino del Laboratorio di Entomologia Agraria 'Filippo Silvestri' di Portici* 41: 23–52.
- Henriquez, N. P. and J. R. Spence. 1993. Studies of *Lathromeroidea* sp. nov. (Hymenoptera: Trichogrammatidae), a parasitoid of gerrid eggs. *The Canadian Entomologist* 125: 693–702.
- Heraty, J. M. and D. Hawks. 1998. Hexamethyldisilazane – A chemical alternative for drying insects. *Entomological News* 109: 369–374.
- Heraty, J. M. and M. E. Schauff. 1998. Mandibular teeth in Chalcidoidea: function and phylogeny. *Journal of Natural History* 32: 1227–1244.
- Hung, A. C. F. 1990. Scale-like structures on the tibia of the parasitic wasps, *Trichogramma* spp. (Hymenoptera: Trichogrammatidae). *Proceedings of the Entomological Society of Washington* 92: 548–551.
- Hutchison, W. D., M. Moratorio, and J. M. Martin. 1990. Morphology and biology of *Trichogrammatoidea bactrae* (Hymenoptera: Trichogrammatidae), imported from Australia as a parasitoid of pink bollworm (Lepidoptera: Gelechiidae) eggs. *Annals of the Entomological Society of America* 83: 46–54.
- Isidoro, N. and F. Bin. 1994. Fine structure of the preocellar pit in *Trissolcus basalidis* (Woll.) (Hymenoptera: Scelionidae). *International Journal of Insect Morphology and Embryology* 23: 189–196.
- Kobayashi, C. and K. Matkoto. 2004. A new species of *Poropoea* (Trichogrammatidae) oviposits by entering through the oviposition hole of attelabid beetle. *Contributions from the Biological Laboratory, Kyoto University* 29: 431–436.
- Kryger, J. P. 1918. The European Trichogramminae. *Entomologiske Meddelelser* 12: 257–354.
- Labeyrie, V. 1962. Influence des parasites oophages sur la regulation des populations de *Cassida deflorata* Suff. *Entomophaga* 6: 257–263.
- Lin, N. Q. 1990. Systematic studies of Trichogrammatidae II. On the species of *Epiligosita* and *Epiligositina* (new status) from China (Hymenoptera, Chalcidoidea). *Journal of the Fujian Agricultural College* 19: 41–51. [In Chinese, English summary].
- Lin, N. Q. 1994. Systematic studies of Chinese Trichogrammatidae. *Contributions of the Biological Control Research Institute, Fujian Agricultural University, Special Publication No. 4*, 362pp. [In Chinese, English summary].
- Livingstone, D. and M. Yacoob. 1983. A new subgenus of *Epiligosita* [Hym.: Trichogrammatidae] an egg parasite of Tingidae [Het.] from southern India. *Entomophaga* 28: 213–216.
- Logarzo, G. A., E. G. Virla, S. V. Triapitsyn, and W. A. Jones. 2004. Biology of *Zagella delicata* (Hymenoptera: Trichogrammatidae), an egg parasitoid of the sharpshooter *Tapajosa rubromarginata* (Hemiptera: Clypeorrhyncha: Cicadellidae) in Argentina. *Florida Entomologist* 87: 511–516.
- Lou, J. and J. Yuan. 1998. A new genus and a new species of Trichogrammatidae (Hymenoptera: Chalcidoidea) from China. *Entomologia Sinica* 5: 22–25.
- Malo, F. 1961. Phoresy in *Xenufens* (Hymenoptera: Trichogrammatidae), a parasite of *Caligo curilochus* (Lepidoptera: Nymphalidae). *Journal of Economic Entomology* 54: 465–466.
- Marlatt, C. L. 1898. The periodical cicada. An account of *Cicada septendecim*, its natural enemies and the means of preventing its injury, together with a summary of the distribution of the different broods. *United States Department of Agriculture, Bulletin* 14(n.s.), 148pp.
- Matheson, R. and C. R. Crosby. 1912. Aquatic Hymenoptera in America. *Annals of the Entomological Society of America* 5: 65–71.
- Nafus, D. M. 1993. Movement of introduced biological control agents onto nontarget butterflies, *Hypolimnas* spp. (Lepidoptera: Nymphalidae). *Environmental Entomology* 22: 265–272.



Nagaraja, H. 1978. Studies on *Trichogrammatoidea* (Hymenoptera: Trichogrammatidae). *Oriental Insects* 12: 489–530.

Nation, J. L. 1983. A new method using hexamethyldisilane for preparation of soft insect tissues for scanning electron microscopy. *Stain Technology* 58: 347–351.

Neto, L. and B. Pintureau. 1997. Review of the genus *Mirufens* Girault (Hymenoptera: Trichogrammatidae). *Entomological Problems* 28: 141–148.

Nowicki, S. 1935. Descriptions of new genera and species of the family Trichogrammatidae (Hym. Chalcidoidea) from the Palearctic Region, with notes—I. *Zeitschrift für Angewandte Entomologie* 21: 566–596.

Nowicki, S. 1936. Descriptions of new genera and species of the family Trichogrammatidae (Hym. Chalcidoidea) from the Palearctic Region, with notes—II. *Zeitschrift für Angewandte Entomologie* 23: 114–148.

Nowicki, S. 1940. Descriptions of new genera and species of the family Trichogrammatidae (Hym. Chalcidoidea) from the Palearctic Region, with notes – Supplement. *Zeitschrift für Angewandte Entomologie* 26: 624–663.

Noyes, J. S. 1982. Collecting and preserving chalcid wasps (Hymenoptera: Chalcidoidea). *Journal of Natural History* 16: 315–334.

Noyes, J. S. 2001. *Interactive catalogue of world Chalcidoidea*. CD-ROM. The Natural History Museum.

Noyes, J. S. 2005. *Universal Chalcidoidea database*. Natural History Museum. <http://internt.nhm.ac.uk/jdsml/perth/chalcidoids/listChalcids.dsml?Superfamily=Chalcidoidea&Family=Trichogrammatidae>.

Noyes, J. S. and E. W. Valentine. 1989. Chalcidoidea (Insecta: Hymenoptera) – introduction, and review of genera in smaller families. *Fauna of New Zealand* 18: 1–91.

Olson, D. M. and D. A. Andow. 1993. Antennal sensilla of female *Trichogramma nubilale* (Ertle and Davis) [sic] (Hymenoptera: Trichogrammatidae) and comparisons with other parasitic Hymenoptera. *International Journal of Insect Morphology and Embryology* 22: 507–520.

Owen, A. K. and J. D. Pinto. 2004. *Pachamama*, an uncommon and distinctive new genus of Trichogrammatidae (Hymenoptera: Chalcidoidea) from tropical America. *Zootaxa* 664: 1–8.

Owen, A. K., J. George, J. D. Pinto, and J. M. Heraty. A molecular phylogeny of the Trichogrammatidae (Hymenoptera: Chalcidoidea), with an evaluation of the utility of male genitalia for higher-level classification. (in prep.)

Pan, Y. C. and G. T. Lim. 1980. The biology of *Tumidielava* sp. (Hymenoptera: Trichogrammatidae), a parasitoid of the sugarcane giant borer *Phragmatoccia gumata* Swinhoe. *Proceedings of the International Society of Sugarcane Technologists*. 17: 1647–1651.

Parra, J. R. P. and R. A. Zucchi. 2004. *Trichogramma* in Brazil: feasibility of use after twenty years of research. *Neotropical Entomology* 33: 271–281.

Perkins, R. C. L. 1906. Leafhoppers and their natural enemies. *Hawaiian Sugar Planters Association (Entomology Bulletin)* 1(8): 238–267.

Pinto, J. D. 1990a. The occurrence of *Chaetostricha* in North America, with the description of a new species (Hymenoptera: Trichogrammatidae). *Proceedings of the Entomological Society of Washington* 92: 208–213.

Pinto, J. D. 1990b. The genus *Xiphogramma*, its occurrence in North America, and remarks on closely related genera (Hymenoptera: Trichogrammatidae). *Proceedings of the Entomological Society of Washington* 92: 538–543.

Pinto, J. D. 1992. Novel taxa of *Trichogramma* from the New World tropics and Australia (Hymenoptera: Trichogrammatidae). *Journal of the New York Entomological Society* 100: 621–633.

Pinto, J. D. 1993. Correct application of the nominal genus *Brachista* Walker (Hymenoptera: Trichogrammatidae). *Proceedings of the Entomological Society of Washington* 95: 298–299.

Pinto, J. D. 1994. A taxonomic study of *Brachista* (Hymenoptera: Trichogrammatidae) with a description of two new species phoretic on robberflies of the genus *Efferia* (Diptera: Asilidae). *Proceedings of the Entomological Society of Washington* 96: 120–132.

Pinto, J. D. 1997a. Trichogrammatidae. In Gibson, G. A. P., J. T. Huber and J. B. Woolley (eds.). *Annotated keys to the genera of Nearctic Chalcidoidea* (Hymenoptera). NRC Research Press, Ottawa, pp. 726–752.

Pinto, J. D. 1997b. *Trichogrammatoidea brasiliensis* (Ashmead) – New combination for a species historically placed in *Trichogramma* (Hymenoptera: Trichogrammatidae). *Proceedings of the Entomological Society of Washington* 99: 593–596.

Pinto, J. D. 1999 (1998). The systematics of the North American species of *Trichogramma* (Hymenoptera: Trichogrammatidae). *Memoirs of the Entomological Society of Washington*. No. 22, 287 pp.

Pinto, J. D. 2004. A review of the genus *Doirania* Waterston (Hymenoptera: Trichogrammatidae), with a description of a new species from North America. *Proceedings of the Entomological Society of Washington* 106: 352–360.

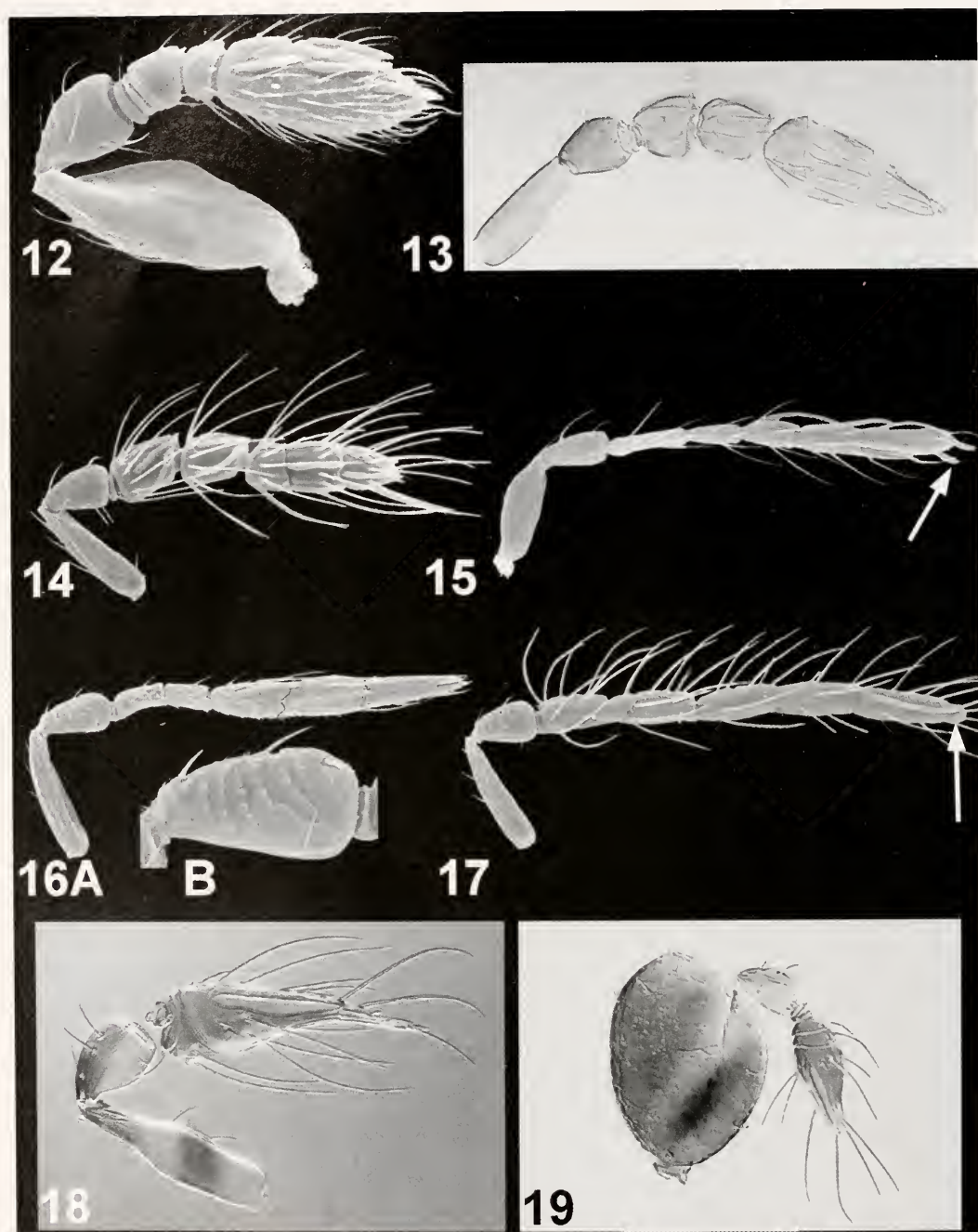
Pinto, J. D. 2005. Descriptions of additional New World Trichogrammatidae (Hymenoptera): the genus *Nicolavespa* and a new species of *Haeckelia*. *Proceedings of the Entomological Society of Washington* 107: 627–641.

Pinto, J. D. and A. K. Owen. 2004. *Adryas*, a new genus of Trichogrammatidae (Hymenoptera: Chalcidoidea) from the New World tropics. *Proceedings of*

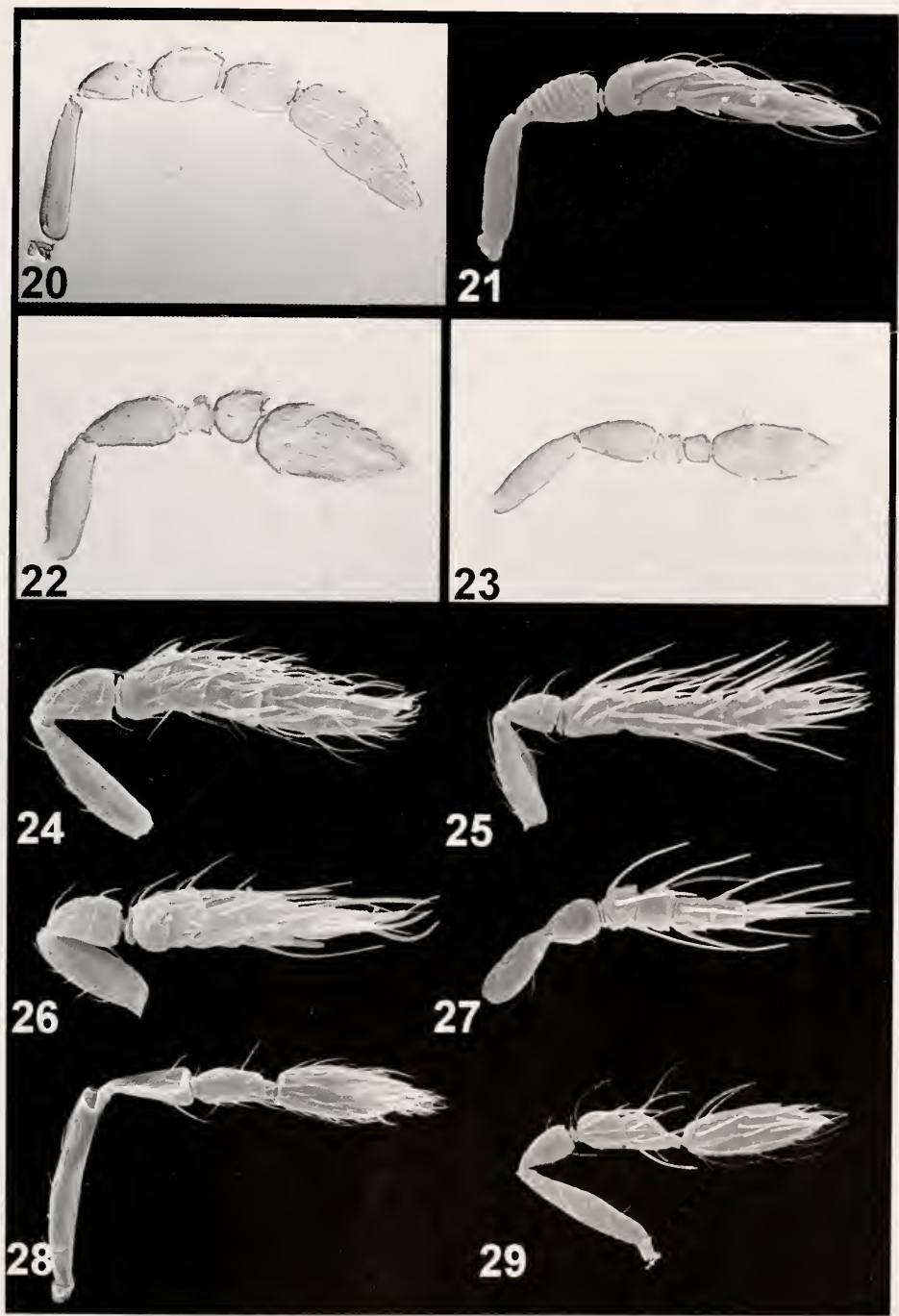
- the Entomological Society of Washington 106: 905–922.
- Pinto, J. D. and R. Stouthamer. 1994. Systematics of the Trichogrammatidae with emphasis on *Trichogramma*. Chap. 1, pp. 1–36. In Wajnberg, E. and S. A. Hassan, eds. Biological control with egg parasitoids. CAB International, Wallingford. 286 pp.
- Pinto, J. D. and G. Viggiani. 1987. Two new Trichogrammatidae (Hymenoptera) from North America: *Ittysella lagunera* Pinto and Viggiani (n. gen, n. sp.) and *Epiligosita mexicana* Viggiani (n. sp.). *The Pan-Pacific Entomologist* 63: 371–376.
- Pinto, J. D. and G. Viggiani. 1991. A taxonomic study of the genus *Ceratogramma* (Hymenoptera: Trichogrammatidae). *Proceedings of the Entomological Society of Washington* 93: 719–732.
- Pinto, J. D. and G. Viggiani. 2004. A review of the genera of Oligositini (Hymenoptera: Trichogrammatidae) with a preliminary hypothesis of phylogenetic relationships. *Journal of Hymenoptera Research* 13: 63–88.
- Pinto, J. D., G. R. Platner, and C. A. Sassaman. 1993. Electrophoretic study of two closely related species of North American *Trichogramma*: *T. pretiosum* and *T. deion* (Hymenoptera: Trichogrammatidae). *Annals of the Entomological Society of America* 86: 702–709.
- Pinto, J. D., G. R. Platner, and R. Stouthamer. 2003. The systematics of the *Trichogramma minutum* Complex (Hymenoptera: Trichogrammatidae), a group of important North American biological control agents: The evidence from reproductive compatibility and allozymes. *Biological Control* 27: 167–180.
- Pintureau, B. 1993. Enzyme polymorphism in some African, American and Asiatic *Trichogramma* and *Trichogrammatoides* species (Hymenoptera: Trichogrammatidae). *Biochemical Systematics and Ecology* 21: 557–573.
- Pintureau, B., M. Gerding, and E. Cisternas. 1999. Description of three new species of Trichogrammatidae (Hymenoptera) from Chile. *The Canadian Entomologist* 131: 53–63.
- Pitcairn, M. 1996. Yellow starthistle control methods: biological control. *Proceedings, California Exotic Pest Plant Council Symposium* 2: 77–80.
- Platner, G. R., R. K. Velten, M. Planoutene, and J. D. Pinto. 1998. Slide-mounting techniques for *Trichogramma* (Trichogrammatidae) and other minute parasitic Hymenoptera. *Entomological News*.
- Polaszek, A., J. LaSalle, and Y. Jongema. 1998. Chalcidoidea. pp. 191–203 in: Polaszek, A., ed. *African cereal stem borers: Economic importance, taxonomy, natural enemies and control*. CAB International, Wallingford Oxon.
- Querino, R. B. and R. A. Zucchi. 2003a. Caracterização morfológica de dez espécies de *Trichogramma* (Hymenoptera: Trichogrammatidae) registradas na América do Sul. *Neotropical Entomology* 32: 597–613.
- Querino, R. B. and R. A. Zucchi. 2003b. Six new species of *Trichogramma* Westwood (Hymenoptera: Trichogrammatidae) from a Brazilian forest reserve. *Zootaxa* 134: 1–11.
- Querino, R. B. and R. A. Zucchi. 2003c. New species of *Trichogramma* associated with lepidopterous eggs in Brazil. *Zootaxa* 163: 1–10.
- Querino, R. B. and R. A. Zucchi. 2004. Redescription of *Trichogrammatoides annulata* De Santis (Hymenoptera: Trichogrammatidae). *Zootaxa* 677: 1–7.
- Schauff, M. E. 1987. Taxonomy and identification of the egg parasites (Hymenoptera: Platygasteridae, Trichogrammatidae, Mymaridae, and Eulophidae) of citrus weevils (Coleoptera: Curculionidae). *Proceedings of the Entomological Society of Washington* 89: 31–42.
- Scheibelreiter, G. K. 1976. First records of two species of egg parasites of *Eldana saccharina* Walk. (Pyralidae, Lep.) on maize in Ghana. *Ghana Journal of Agricultural Science* 9: 147–148.
- Scheibelreiter, G. K. 1980. Sugarcane stem borers (Lep.: Noctuidae and Pyralidae) in Ghana. *Zeitschrift für Angewandte Entomologie* 89: 87–99.
- Smith, S. M. 1996. Biological control with *Trichogramma*: Advances, successes, and potential of their use. *Annual Review of Entomology* 41: 375–406.
- Snodgrass, R. E. 1957. A revised interpretation of the external reproductive organs of male insects. *Smithsonian Miscellaneous Collections*, vol 136, No. 6, 60pp.
- Sorokina, A. P. 1993. Key to species of the genus *Trichogramma* Westw. (Hymenoptera, Trichogrammatidae) of the world fauna. Kolos Publishing House, Moscow. 77 pp. [In Russian].
- Srivastava, M. L., R. P. Singh, and B. Parshad. 1970. New records of hymenopterous parasites of membracids. *Indian Journal of Entomology* 31: 375–376.
- Subba Rao, B. R. 1969. Two new species of *Poropoea* Förster from the orient with a key to species (Hymenoptera: Trichogrammatidae). *Oriental Insects* 3: 319–325.
- Sundararaju, D. 1993. Studies on the parasitoids of tea mosquito bug, *Helopeltis antonii* Sign. (Heteroptera: Miridae) on cashew with special reference to *Telenomus* sp. (Hymenoptera: Scelionidae). *Journal of Biological Control* 7: 6–8.
- Timberlake, P. H. 1924. Descriptions of new chalcid-flies from Hawaii and Mexico (Hymenoptera). *Proceedings of the Hawaiian Entomological Society* 5: 395–417.
- Timberlake, P. H. 1927. New species of Hawaiian chalcid-flies (Hymenoptera)—II. *Proceedings of the Hawaiian Entomological Society*. 6: 517–528.
- Tipping, C., S. V. Triapitsyn, and R. F. Mizell III. 2005. A new host record for the egg parasitoid *Paracentrobia americana* (Girault) (Hymenoptera:

- Trichogrammatidae) of the proconiine sharp-shooter *Homalodisca insolita* (Walker) (Hemiptera: Clypeorrhyncha: Cicadellidae). *Florida Entomologist* 88: 217–218.
- Triapitsyn, S. V. 2003. Taxonomic notes on the genera and species of Trichogrammatidae (Hymenoptera) – egg parasitoids of the proconiine sharpshooters (Hemiptera: Clypeorrhyncha: Cicadellidae: Proconiini) in southeastern USA. *Transactions of the American Entomological Society* 129: 245–265.
- Triapitsyn, S. V., R. F. Mizell III, J. L. Bossart, and C. E. Carlton. 1998. Egg parasitoids of *Homalodisca coagulata* (Homoptera: Cicadellidae). *Florida Entomologist* 81: 241–243.
- Trjapitzin, S. V. 1995. A new species of *Aphelinoidea* (Hymenoptera: Trichogrammatidae), with a key to species of the Holarctic Region. *Journal of the Kansas Entomological Society* 67: 301–310.
- Velten, R. K. and J. D. Pinto. 1990. *Soikiella* Nowicki (Hymenoptera: Trichogrammatidae): occurrence in North America, description of a new species, and association of the male. *The Pan-Pacific Entomologist* 66: 246–250.
- Viggiani, G. 1968. Ricerche sugli Hymenoptera Chalcidoidea XVII. Nuove specie di Trichogrammatidae. *Bollettino del Laboratorio di Entomologia Agraria 'Filippo Silvestri' di Portici* 26: 251–262.
- Viggiani, G. 1971. Ricerche sugli Hymenoptera Chalcidoidea XXVIII. Studio morfologico comparativo dell'armatura genitale esterne maschile dei Trichogrammatidae. *Bollettino del Laboratorio di Entomologia Agraria 'Filippo Silvestri' di Portici* 29: 181–222.
- Viggiani, G. 1976a. Ricerche sugli Hymenoptera Chalcidoidea XLIX. *Trichogramma confusum* n. sp. per *T. australicum* Nagarkatti e Nagaraja (1968), nec Girault (1912), con note su *Trichogrammatoides* Girault e descrizione di *Paratrichogramma heliothidis* n. sp. *Bollettino del Laboratorio di Entomologia Agraria 'Filippo Silvestri' di Portici* 33: 182–187.
- Viggiani, G. 1976b. Ricerche sugli Hymenoptera Chalcidoidea L. Materiali per una revisione del genere *Oligosita* Walk. (Trichogrammatidae). 1. Le specie australiane descritte da A. A. Girault. *Bollettino del Laboratorio di Entomologia Agraria 'Filippo Silvestri' di Portici* 33: 188–218.
- Viggiani, G. 1984. Further contribution to the knowledge of the male genitalia in the Trichogrammatidae (Hym. Chalcidoidea). *Bollettino del Laboratorio di Entomologia Agraria 'Filippo Silvestri' di Portici* 41: 173–182.
- Viggiani, G. 1985. Parassiti oofagi delle cicaline delle querce: *Epoligosita vera* Viggiani. *Atti Congresso Nazionale Italiano di Entomologia XIV*: 867–872.
- Viggiani, G. 1986. Description of a new species of *Uscana* Girault from Congo, with notes on other species (Hymenoptera: Trichogrammatidae). *Bollettino del Laboratorio di Entomologia Agraria 'Filippo Silvestri' di Portici* 43: 7–10.
- Viggiani, G. 1989. Description of *Pintoa nearctica*, gen. nov., sp. nov. (Hymenoptera: Trichogrammatidae). *Bollettino del Laboratorio di Entomologia Agraria 'Filippo Silvestri' di Portici* 45(1988): 23–29.
- Viggiani, G. 1992. New species of Trichogrammatidae (Hymenoptera: Chalcidoidea) from South America. *Redia* 75: 253–265.
- Viggiani, G. and M. Hayat. 1974. New trichogrammatids from India (Hymenoptera: Chalcidoidea). *Bollettino del Laboratorio di Entomologia Agraria 'Filippo Silvestri' di Portici* 31: 145–151.
- Viggiani, G. and S. Laudonia. 1994. Description of a new species of *Lathromeris* Foerster (Hymenoptera: Trichogrammatidae) larval parasitoid of *Lasiopoda* sp. (Diptera: Cecidomyiidae). *Bollettino del Laboratorio di Entomologia Agraria 'Filippo Silvestri' di Portici* 49: 169–172.
- Viggiani, G. and J. Pinto. 2003. Description of *Sinepalpigramma*, a new genus of Trichogrammatidae (Hymenoptera: Chalcidoidea), including two new species. *Bollettino del Laboratorio di Entomologia Agraria 'Filippo Silvestri' di Portici* 58(2002): 117–122.
- Viggiani, G. and M. Velasquez. 2004. Description of *Pteranomalogramma singulare* n. gen., n. sp. (Hymenoptera: Trichogrammatidae), from Venezuela. *Bollettino del Laboratorio di Entomologia Agraria 'Filippo Silvestri' di Portici* 59(2003): 87–91.
- Vincent, D. L. and C. Goodpasture. 1986. Three new species of *Trichogramma* (Hymenoptera: Trichogrammatidae) from North America. *Proceedings of the Entomological Society of Washington* 88: 491–501.
- Walker, G. P., I. M. Bayoun, S. V. Triapitsyn, and J. Y. Honda. 2005. Taxonomy of *Aphelinoidea* (Hymenoptera: Trichogrammatidae) species attacking eggs of the beet leafhopper, *Circulifer tenellus* (Hemiptera: Cicadellidae) in California. *Zootaxa* 1068: 1–25.
- Yousuf, M. and Shafee, S. A. 1988. Taxonomy of Indian Trichogrammatidae (Hymenoptera: Chalcidoidea). *Indian Journal of Systematic Entomology* 4: 55–200.
- Yoshimoto, C. M. 1976. *Pseudoxenofens forsythi* a new genus and species of Trichogrammatidae (Hymenoptera: Chalcidoidea) from western Ecuador. *The Canadian Entomologist* 108: 419–422.
- Zucchi, R. A. and R. C. Monteiro. 1997. O gênero *Trichogramma* na América do Sul. Chap. 2, Pp. 41–66 in: Parra, J. R. and A. Zucchi, eds. *Trichogramma e o Controle Biológico Aplicado*. FEALQ, Piracicaba, SP, Brasil. 324 pp.

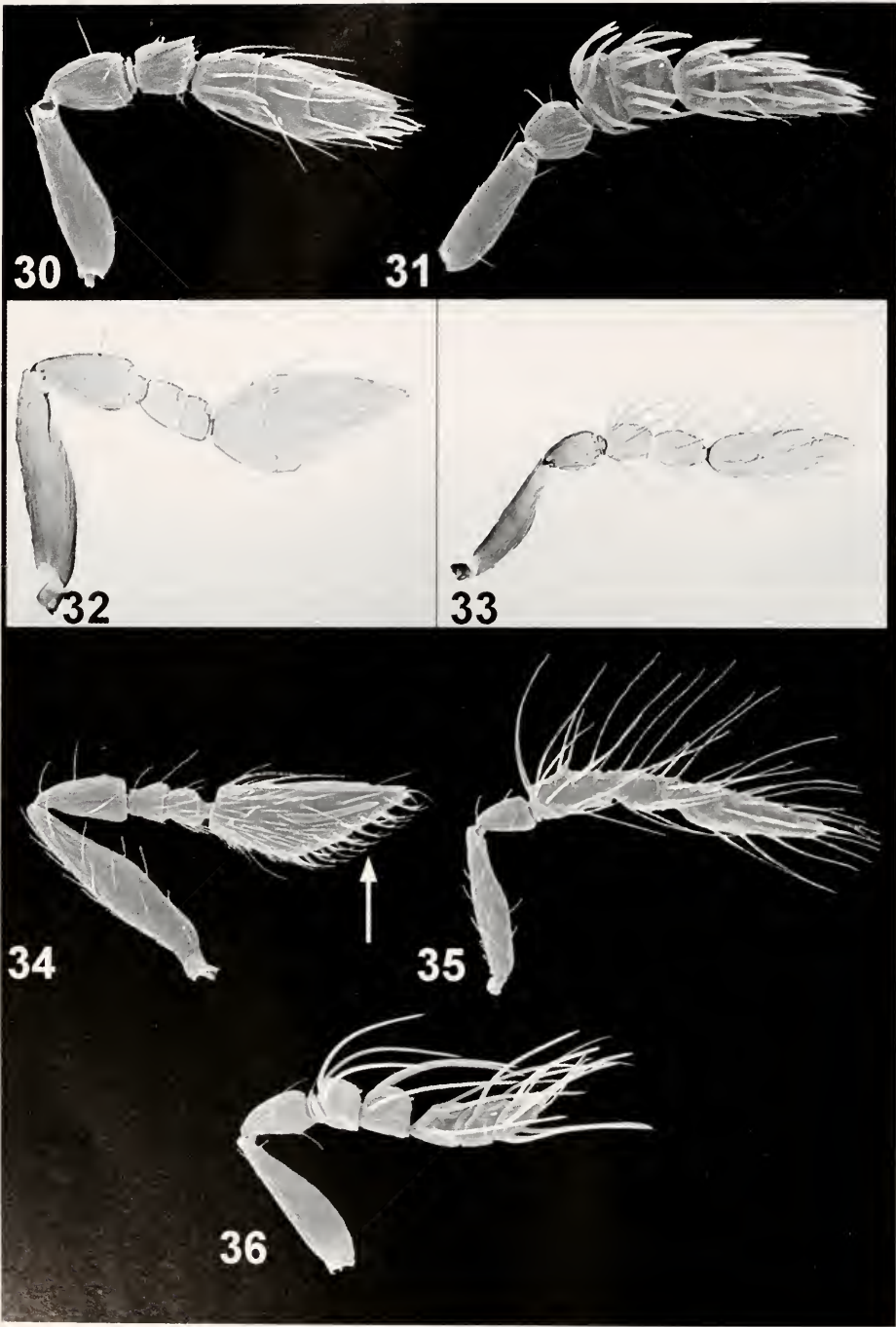




Figs 12–19. Antennae. 12, *Ceratogramma masneri* (♀). 13, *Ceratogramma jeffersi* (♀). 14, *Ceratogramma jeffersi* (♂). 15, *Hydrophylita* (♀) (arrow to unique spatulate sensilla). 16, *Mirufens* (♀): A – full; B – detail of pedicel showing crenulate transverse ridges. 17, *Mirufens* (♂) (arrow to small 4<sup>th</sup> club segment). 18, *Pachamama speciosa* (♀). 19, *Pachamama speciosa* (♂).

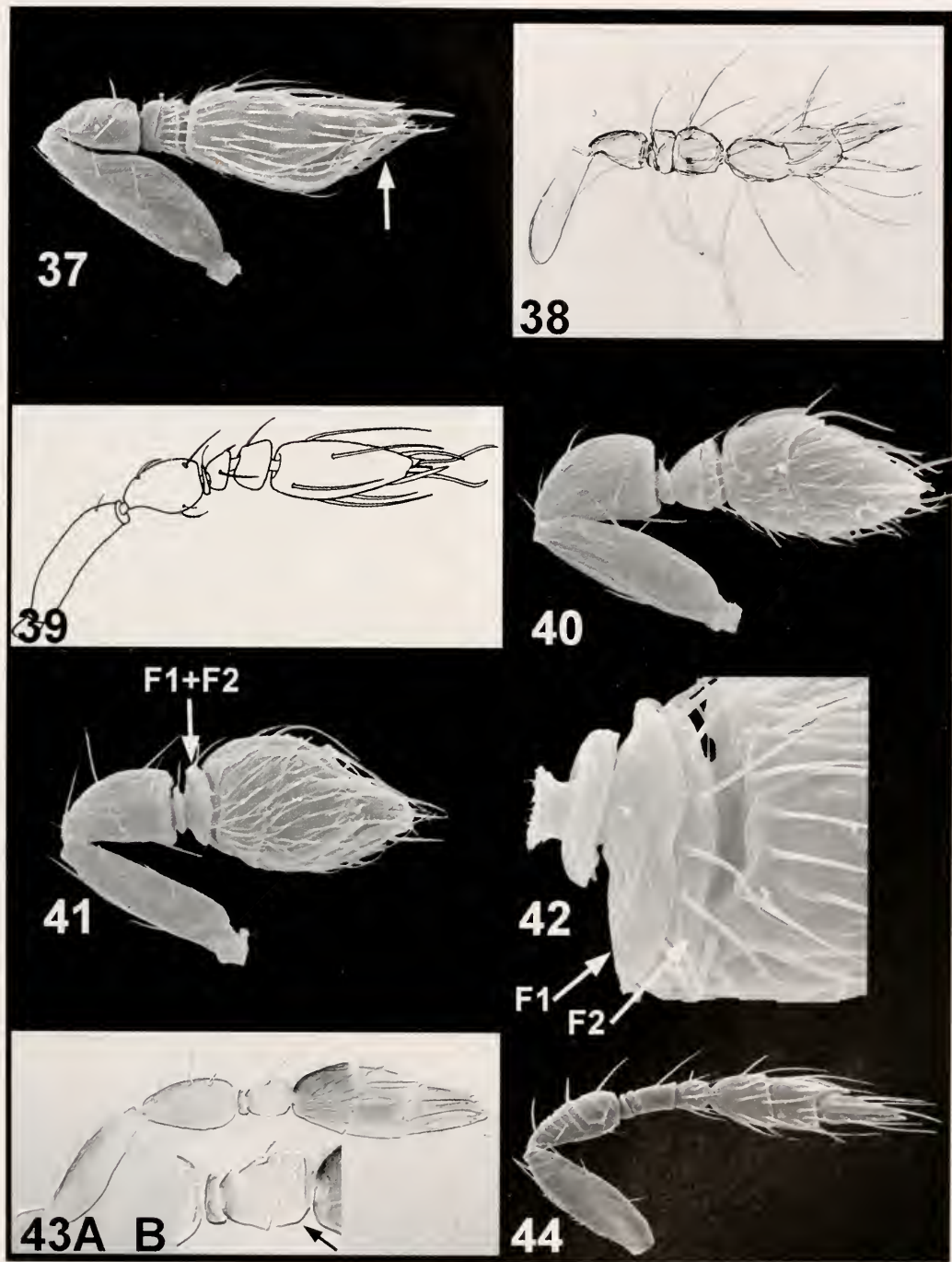


Figs 20–29. Antennae. 20, *Poropoea* (♀). 21, *Trichogrammatella* (♀). 22, *Pterandrophysalis leventina* (♀). 23, *Pterandrophysalis leventina* (♂). 24, *Brachyufens osborni* (♀). 25, *Brachyufens osborni* (♂). 26, *Haeckeliania sperata* (♀). 27, *Haeckeliania sperata* (♂). 28, *Paratrachogramma californica* (♀). 29, *Paratrachogramma californica* (♂).

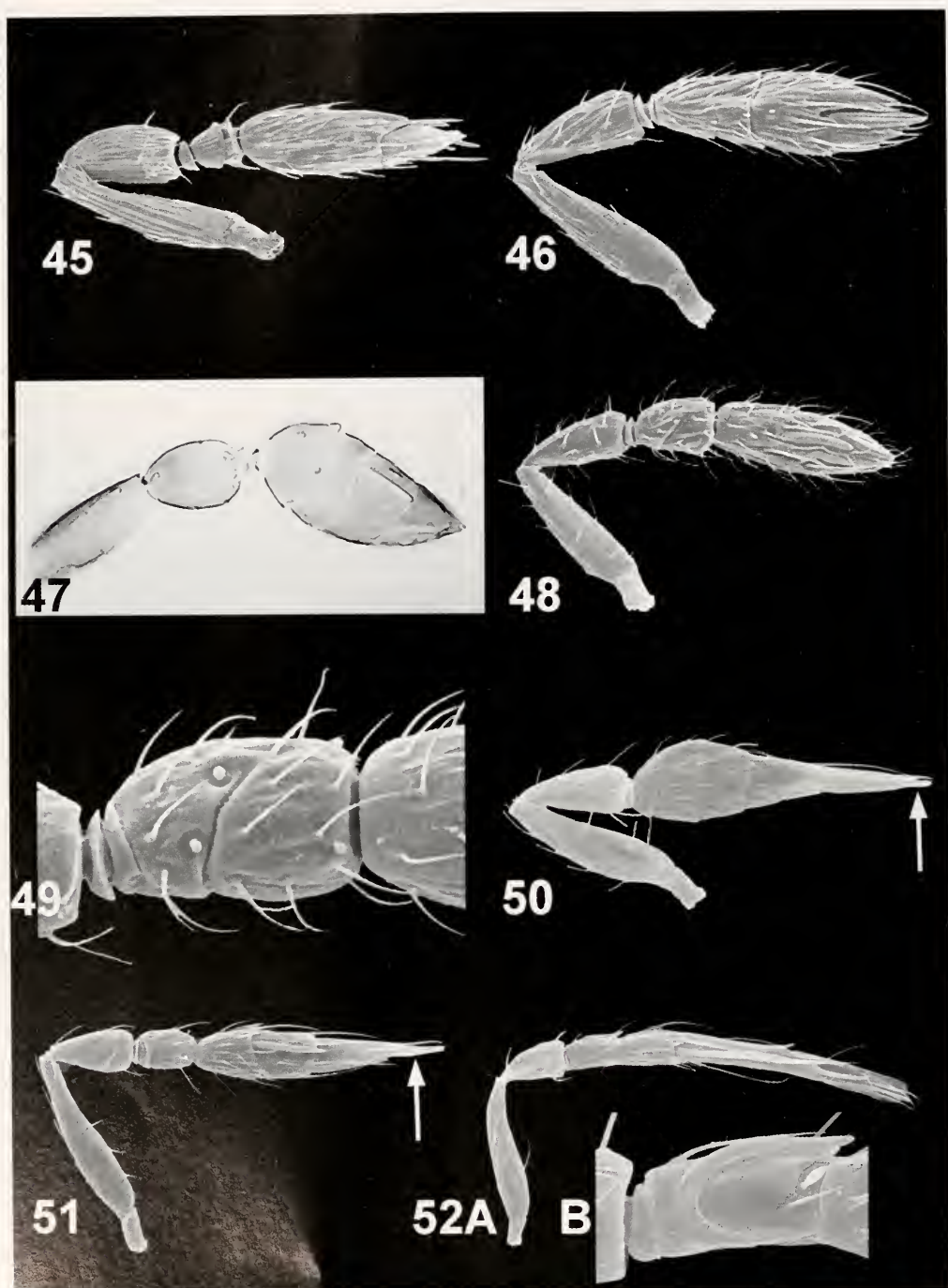


Figs 30–36. Antennae. 30, *Soikiella occidentalis* (♀). 31, *Soikiella occidentalis* (♂). 32, *Thanatogramma oweni* (♀). 33, *Thanatogramma oweni* (♂). 34, *Trichogramma pretiosum* (♀) (arrow to patch of RS). 35, *Trichogramma pretiosum* (♂). 36, *Trichogrammatoidea bactrae* (♂).

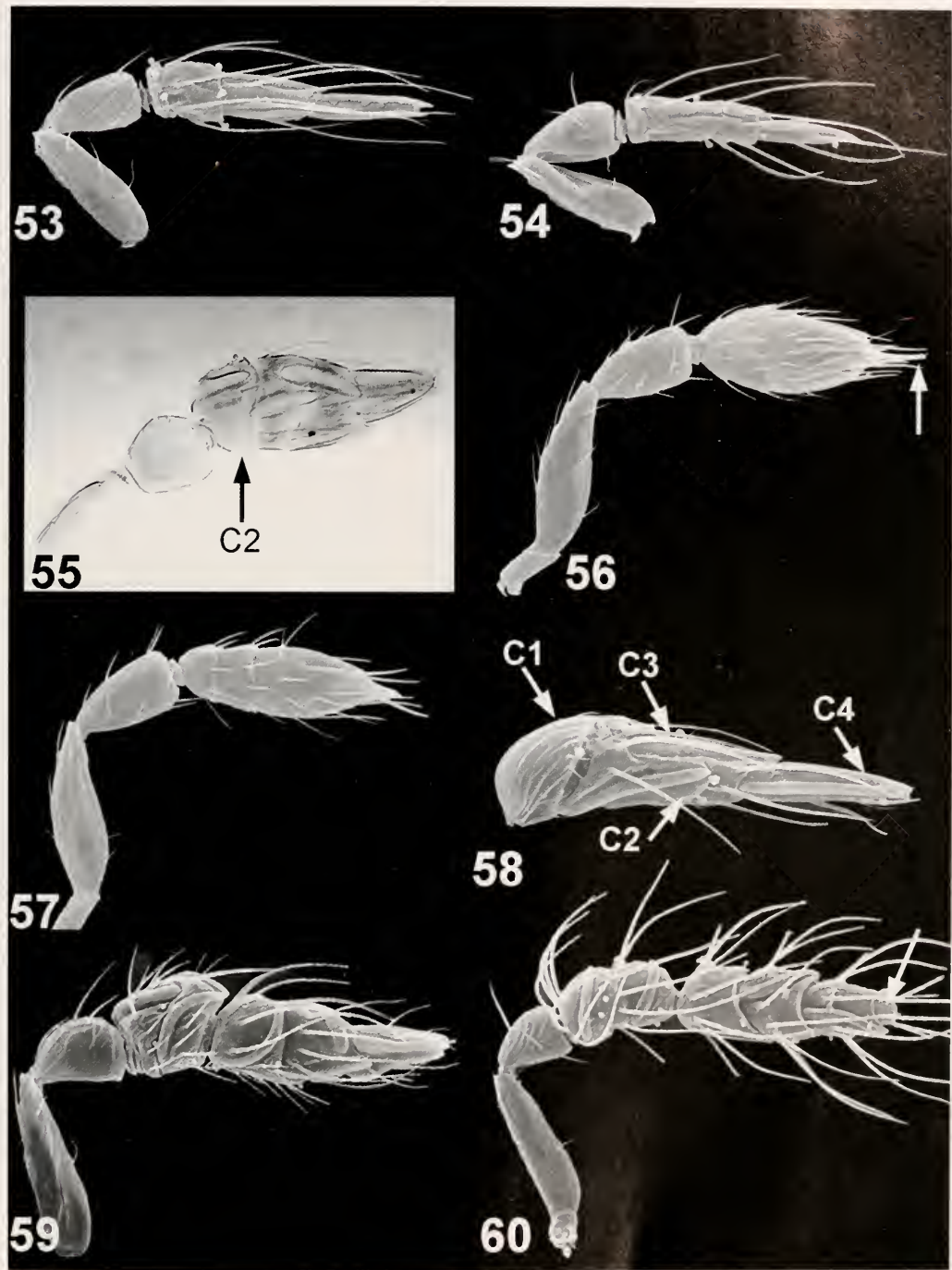




Figs 37–44. Antennae. 37, *Trichogrammatomyia* (♀) (arrow to patch of RS). 38, *Trichogrammatomyia* (♂). 39, *Viggianiella tropica* (♀). 40, *Xenufens ruskini* (♀). 41, *Xenufens forsythi* (♀) (lateral, F1 and F2 fused). 42, *Xenufens forsythi* (♀) (medial, F1 and F2 distinct). 43, *Paracentrobia* (♀): A – full, B – detail of funicle (arrow to F2). 44, *Ittys* (♀).

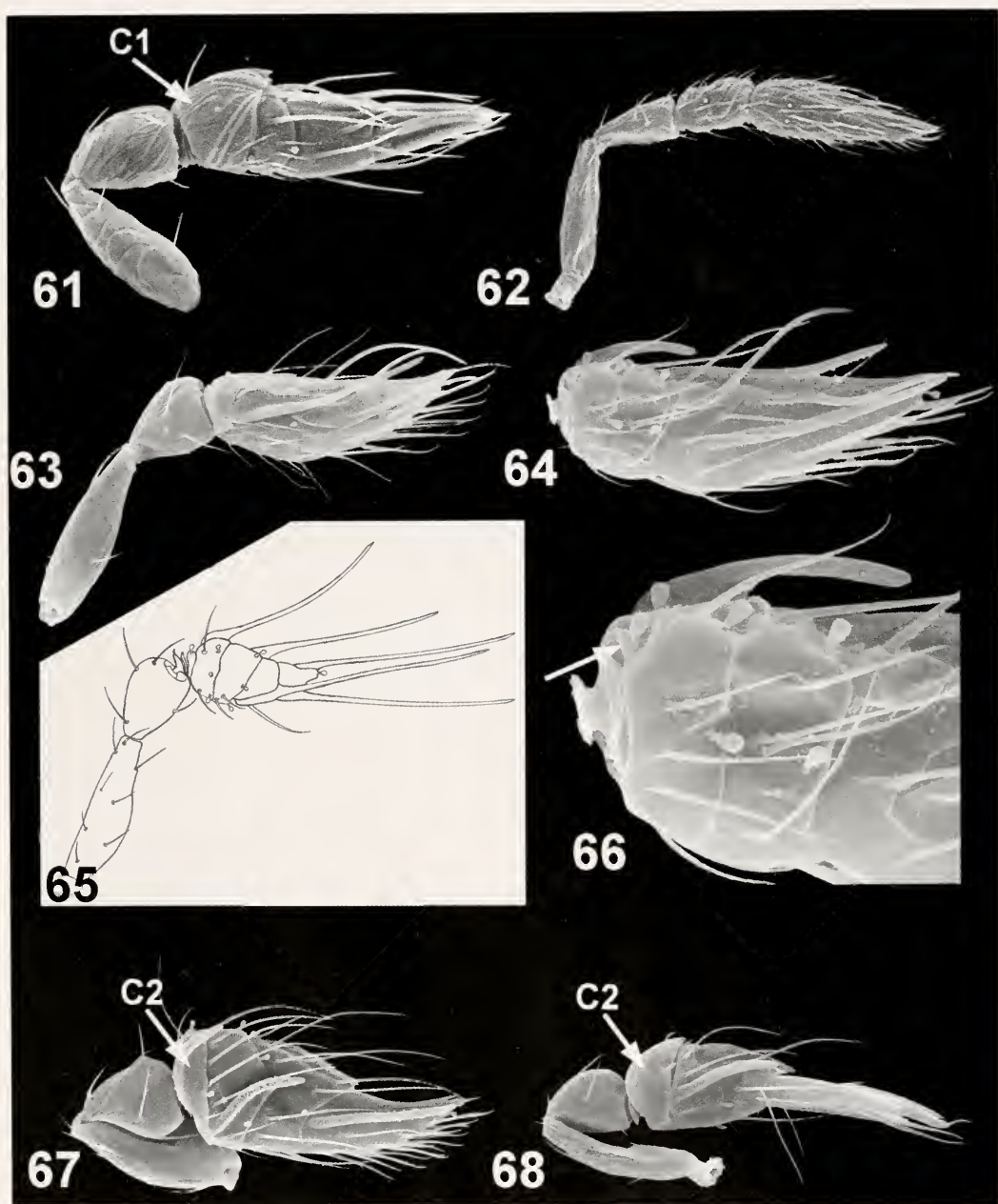


Figs 45-52. Antennae (♀♀). 45, *Ittysella lagunera*. 46, *Aphelinoidea*. 47, *Brachista fidiac*. 48, *Chaetogramma occidentalis*. 49, same (detail of funicle, medial). 50, *Lathromeris hesperus* (arrow to terminal process). 51, *Nicolavespa theresae* (arrow to terminal process). 52, *Pintoa nearctica*: A - full; B - detail of funicle showing J-shaped PLS.

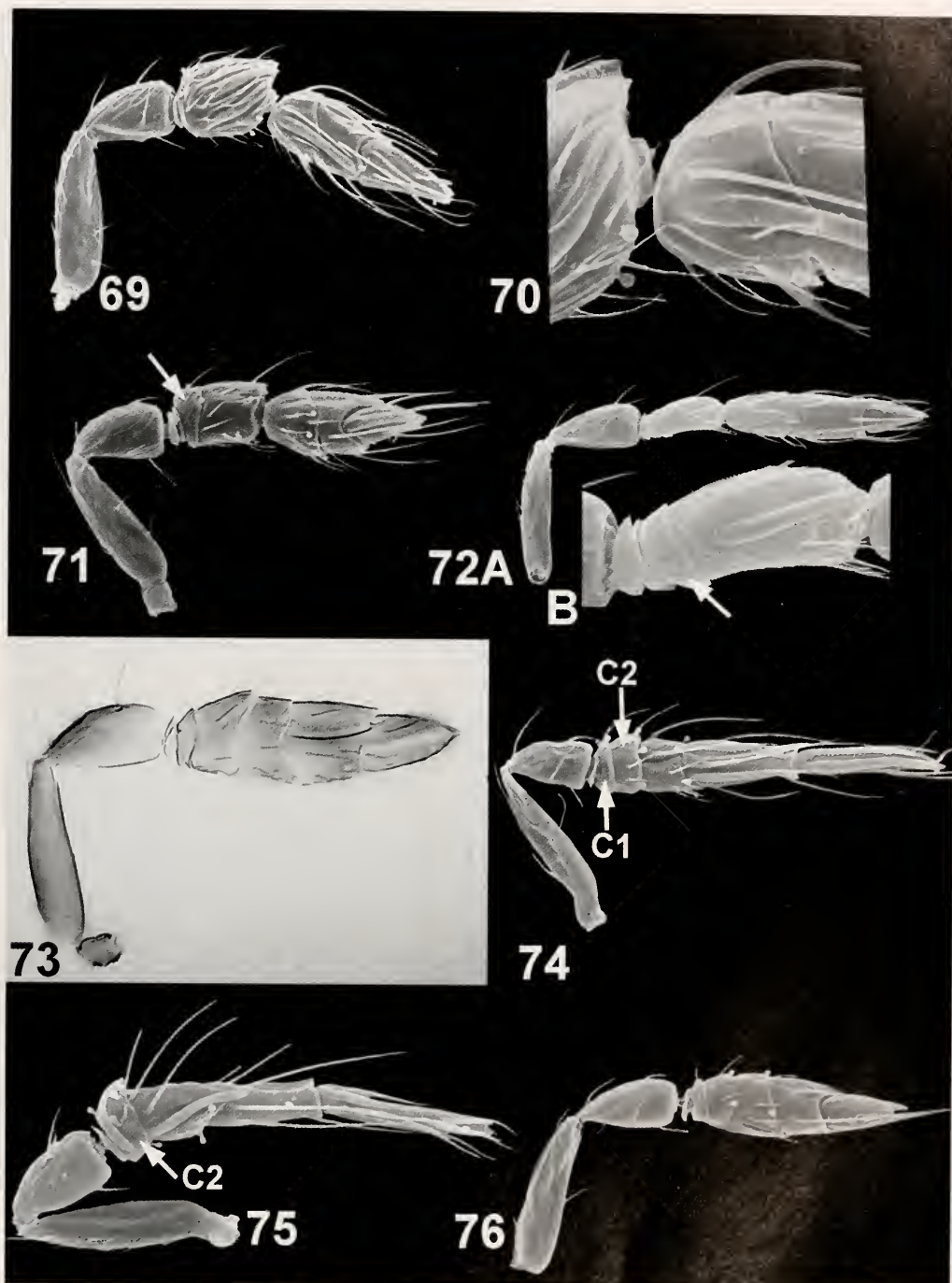


Figs 53–60. Antennae. 53, *Pseuduscana sola* (♀). 54, same (♂). 55, *Pterygogrammia* (♀). 56, *Tunidiclava* (♀) (arrow to terminal process). 57, Same (♂). 58, *Tunidifemur* (♀) (note segment asymmetry, especially of C2 and C3). 59, *Ulfens* (♀). 60, same (♂) (arrow to small 4<sup>th</sup> club segment).

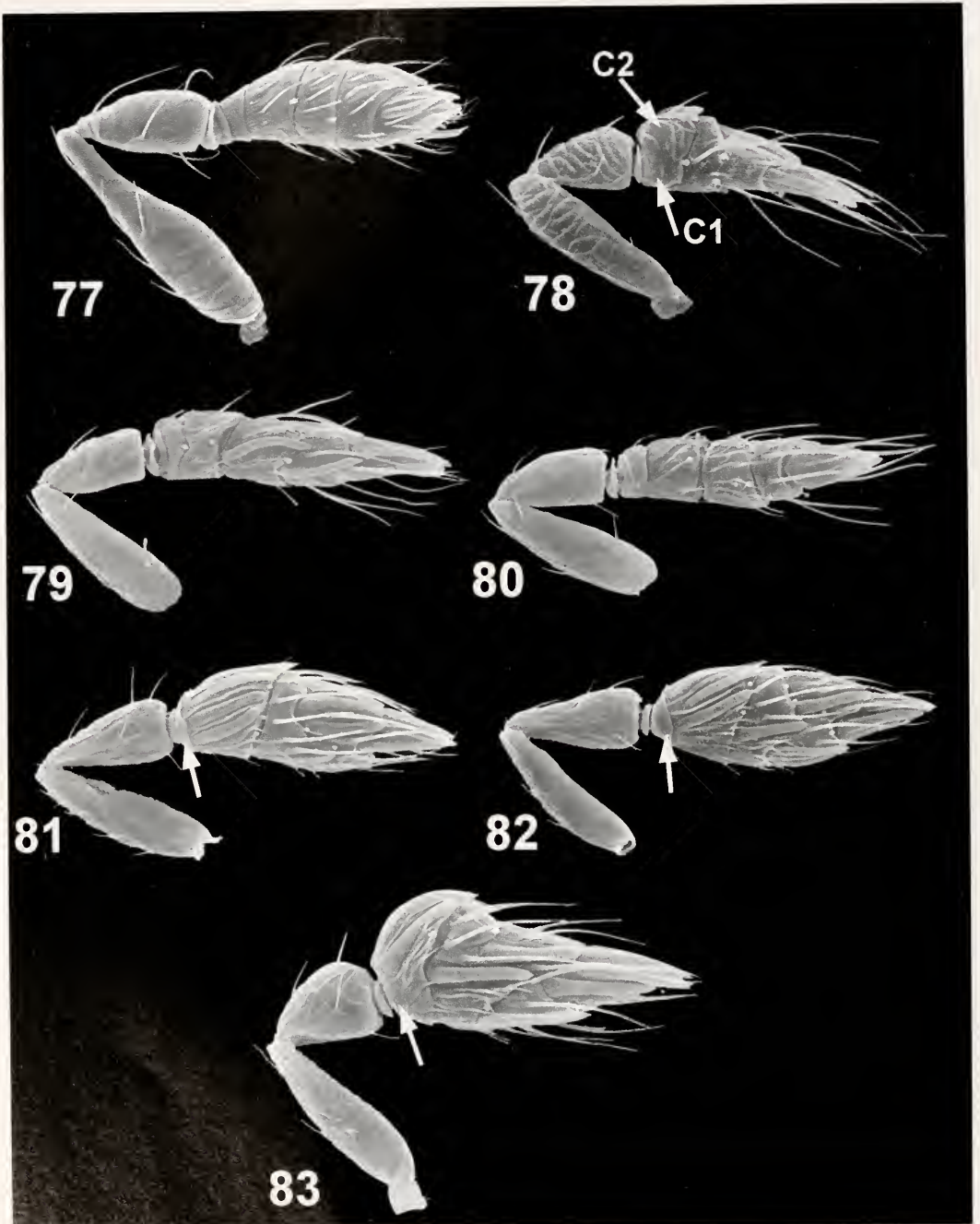




Figs 61–68. Antennae. 61, *Ulcana semifumipennis* (♀). 62, *Xiphogramma fuscum* (♀). 63, *Adelogramma primum* (♀) (lateral). 64, same (♀) (medial of club). 65, same (♂). 66, same (♀) (detail of base of club, medial; arrow to very small C1). 67, *Adryas magister* (♀). 68, *Adryas bochica* (♀). Note C1 not visible in lateral views of *Adelogramma* and *Adryas* ♀.

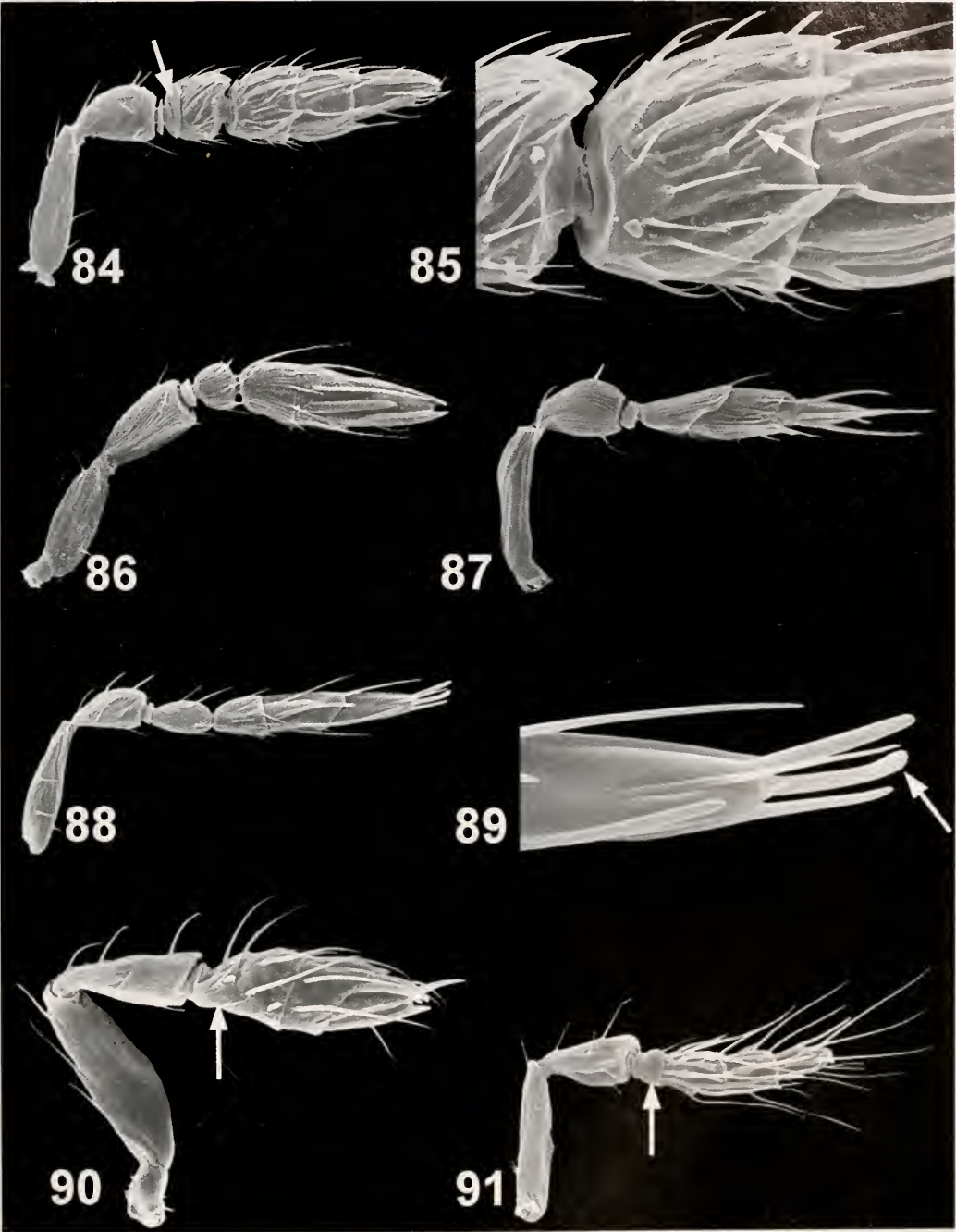


Figs 69–76. Antennae. 69, *Burksiella spirita* (♀) (lateral, F1 not visible). 70, same (♀) (detail of base of club; note absence of APB sensilla on C1 [compare with *Zagella* in Fig. 85]). 71, same (♂) (medial, arrow to F1). 72, *Chaetostricha* (♀): A – full; B – detail of funicle (medial, arrow to F1). 73, *Lathromeroidea* (♀) (Group A). 74, *Lathromeroidea* (♀) (Group B) (medial, C1 visible). 75, same (♀) (lateral, C1 not visible). 76, same (♂) (medial).

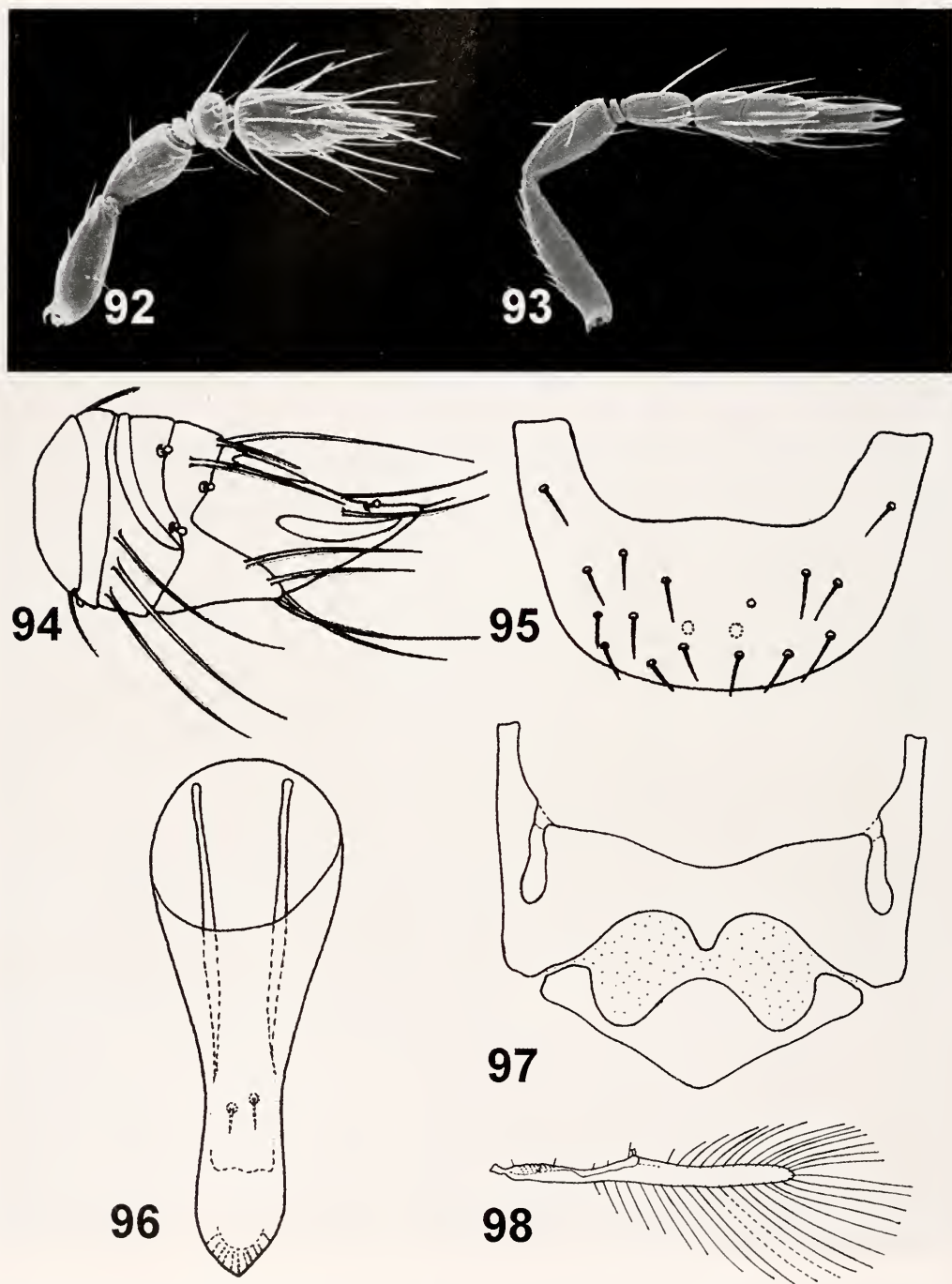


Figs 77-83. Antennae. 77, *Lathromeroidea gerriphaga* (♀) (Group C). 78, *Uscanoida* (♂). 79, *Centrobiopsis odonatae* (♀) (medial). 80, same (♂) (medial). 81, *Zaga* sp. 1 (♀) (lateral, arrow to C1). 82, same (♂). 83, *Zaga* sp. 2 (♀) (lateral, arrow to C1).

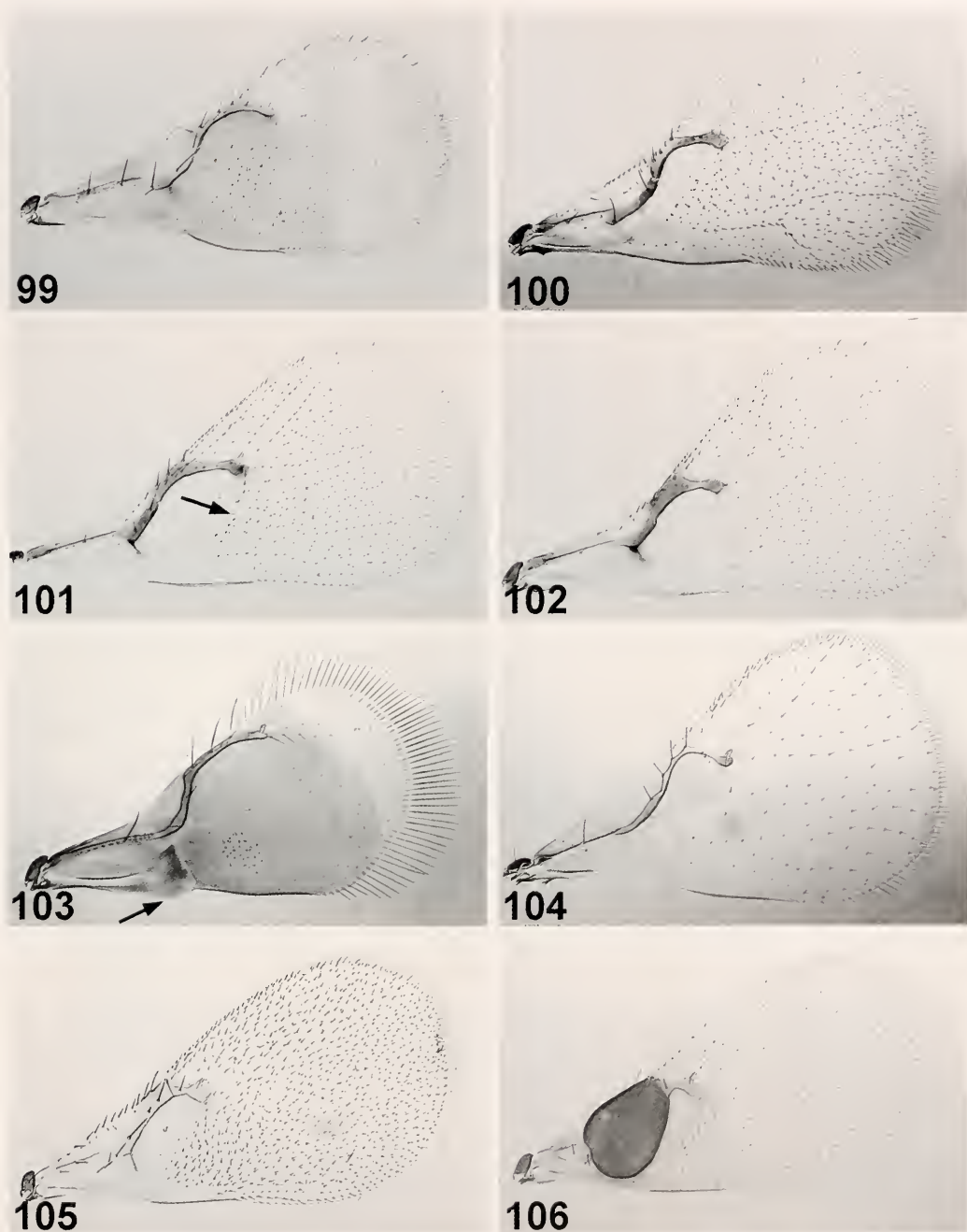




Figs 84–91. Antennae (♀♀). 84, *Zagella* (medial, arrow to F1). 85, same (arrow on C1 to APB sensillum; compare with *Burksiella spirita*, Fig. 70). 86, *Epoligosita*. 87, *Megaphragma*. 88, *Oligosita* (*collina* group). 89, same (detail of club apex, arrow to clavate PLS). 90, *Prestwichia* (arrow to F1). 91, *Sinepalpigramma longiciliatum* (arrow to F1).

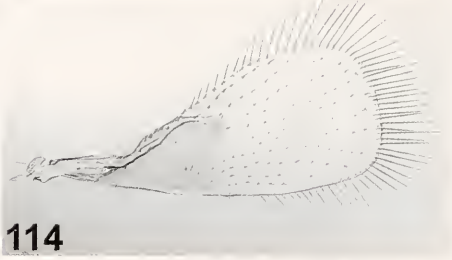
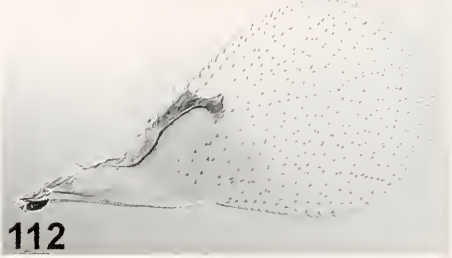


Figs 92-98. 92-93, antennae. 92, *Doirania elegans* (♀). 93, *Pseudoligosita* (♀). 94-96, *Pterygogramma marquesi* (types). 94, antennal club (♀). 95, scutellum (♀). 96, ♂ genitalia (dorsal; ventral setae are dotted). 97-98, *Viggianiella tropica* (♀). 97, propodeum and petiolar segment. 98, hind wing.

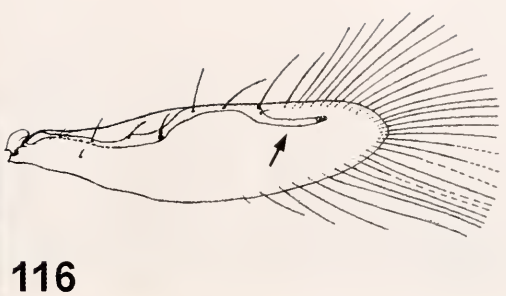


Figs 99–106. Fore wings. 99, *Ceratogramma masneri*. 100, *Ceratogramma jeffersi*. 101, *Mirufens* sp. 1 (arrow to RS1). 102, *Mirufens* sp. 2. 103, *Pachamama speciosa* (arrow to preretinal lobe). 104, *Poropoca*. 105, *Pterandrophysalis levantina* (♀). 106, same (♂).

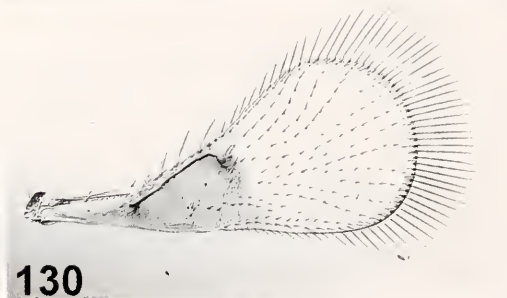
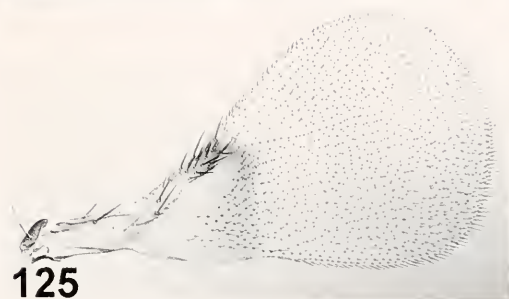




Figs 107–114b. Fore wings. 107, *Trichogrammatella*. 108, *Brachyufens osborni*. 109, *Haeckeliania sperata*. 110, *Paratrachogramma californica*. 111, *Soikiella occidentalis*. 112, *Thanatogramma oweni*. 113, *Trichogramma*. 114, *Trichogrammatoidea*. 114a, *Hydrophylita* (*Hydrophylita*). 114b, *Hydrophylita* (*Lutzimicron*).

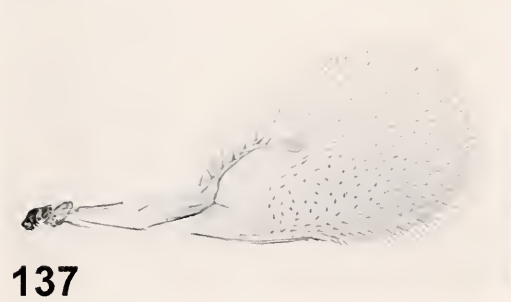
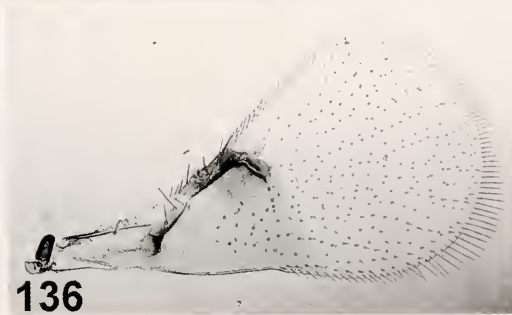
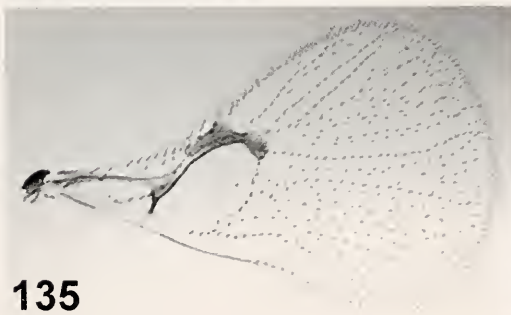


Figs 115–122. Fore wings. 115, *Trichogrammatomyia*. 116, *Viggianiella tropica* (arrow to stigmal vein). 117, *Xenifens ruskini*. 118, *Paracentrobia*. 119, *Ittys* (arrow to RS1). 120, *Ittysella lagunera*. 121, *Aphelinoidea* (*Aphelinoidea*) (*semifuscipennis* Group). 122, *Aphelinoidea* (*Aphelinoidea*) (*plutella* group).

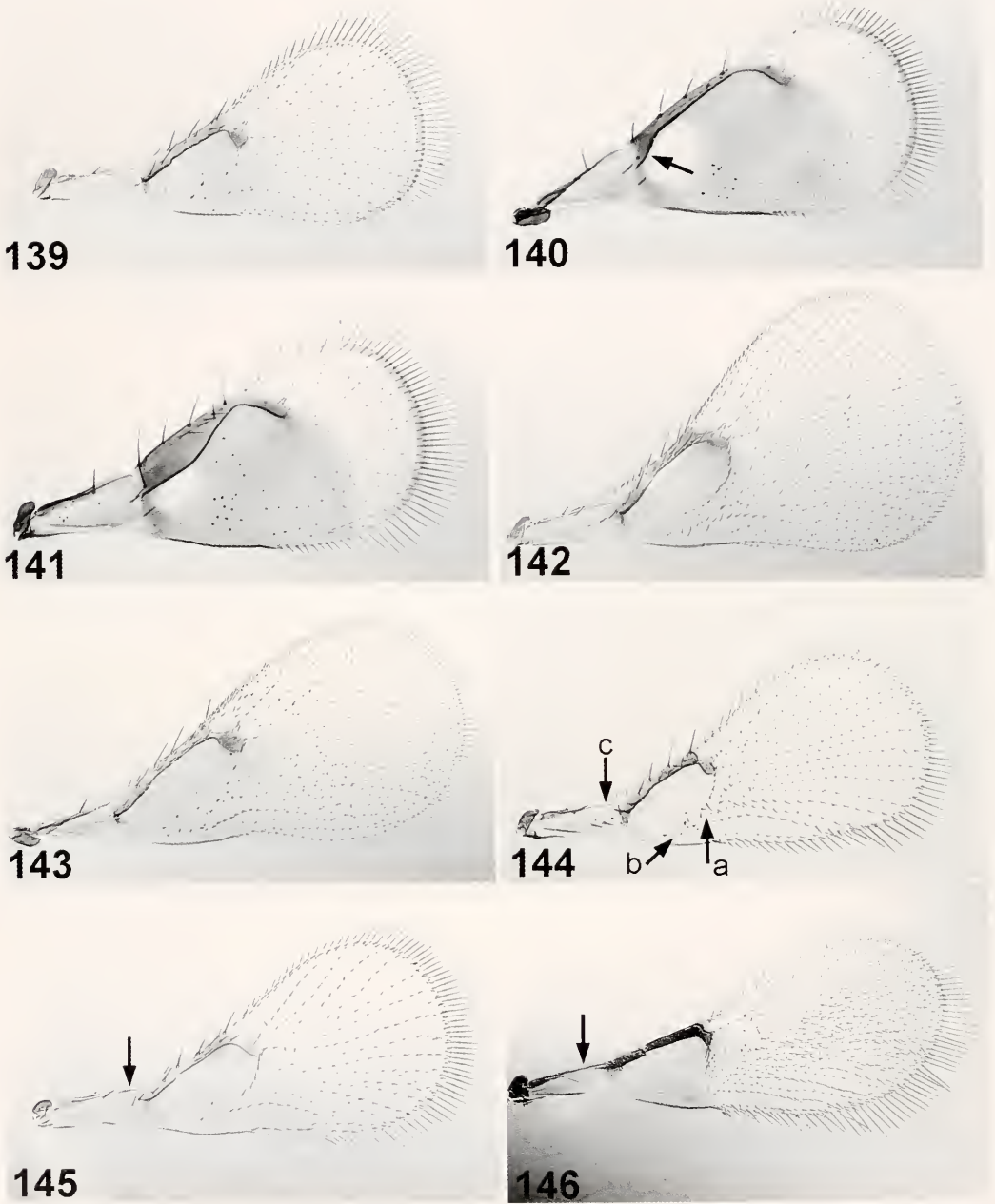


Figs 123–130. Fore wings. 123, *Aphelinoidea* (*Encyrtogramma*). 124, *Brachista fidae*. 125, *Brachygrammatella*. 126, *Chaetogramma occidentalis* (arrow to lightly pigmented area at junction of premarginal and marginal veins). 127, *Lathromeris hesperus*. 128, *Nicolavespa*. 129, *Pintoa nearctica*. 130, *Pseuduscana sola*.

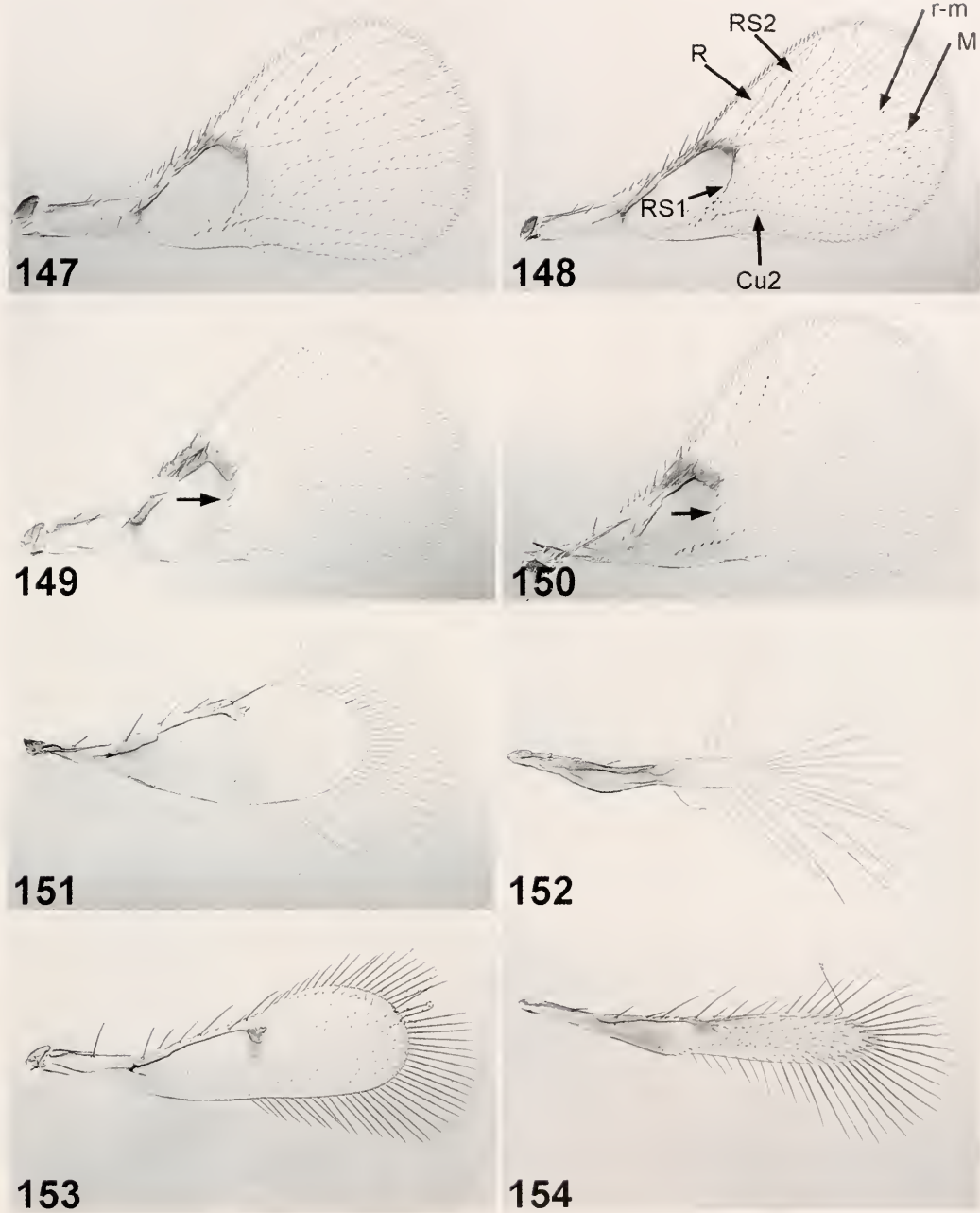




Figs 131–138. Fore wings. 131, *Pterygogramma*. 132, *Tumidiclava*. 133, *Tumidifemur* sp. 1. 134, *Tumidifemur* sp. 2. 135, *Ufens*. 136, *Uscana semifumipennis*. 137, *Uscanopsis carlyei* (type). 138, *Xiphogramma fuscum*.



Figs 139–146. Fore wings. 139, *Adelogramma primum*. 140, *Adryas magister* (♀) (arrow to premarginal vein). 141, same (♂). 142, *Burksiella spirita*. 143, *Chaetostricha*. 144, *Lathromeroidea* (Group A) ('a' to basal convergence of setal tracks, 'b' to setal line anterior to retinaculum, 'c' to terminus of subcostal vein anterior to base of premarginal vein). 145, *Lathromeroidea exemplum* (Group B) (arrow to terminus of subcostal vein anterior to base of premarginal vein). 146, *Lathromeroidea gerriphaga* (Group C) (arrow to subcostal vein, confluent with premarginal vein).

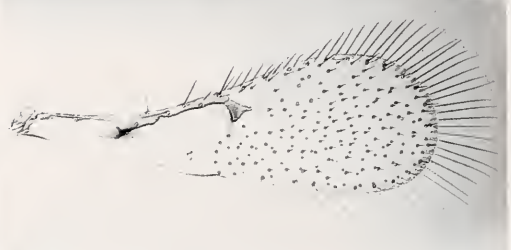


Figs 147–154. Fore wings. 147, *Uscanoidea*. 148, *Centrobiopsis odonatae* (with important setal tracks characterizing most trichogrammatid wings indicated). 149, *Zaga* (arrow at RS1). 150, *Zagella* (arrow at RS1). 151, *Epoligosita*. 152, *Megaphragma*. 153, *Oligosita*. 154, *Prestwichia*.





155



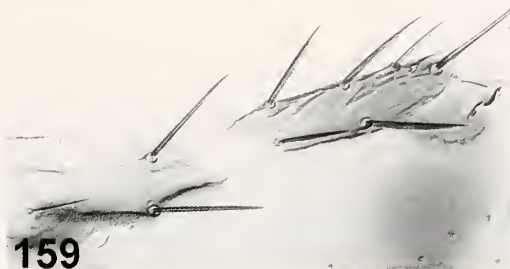
156



157



158



159



160

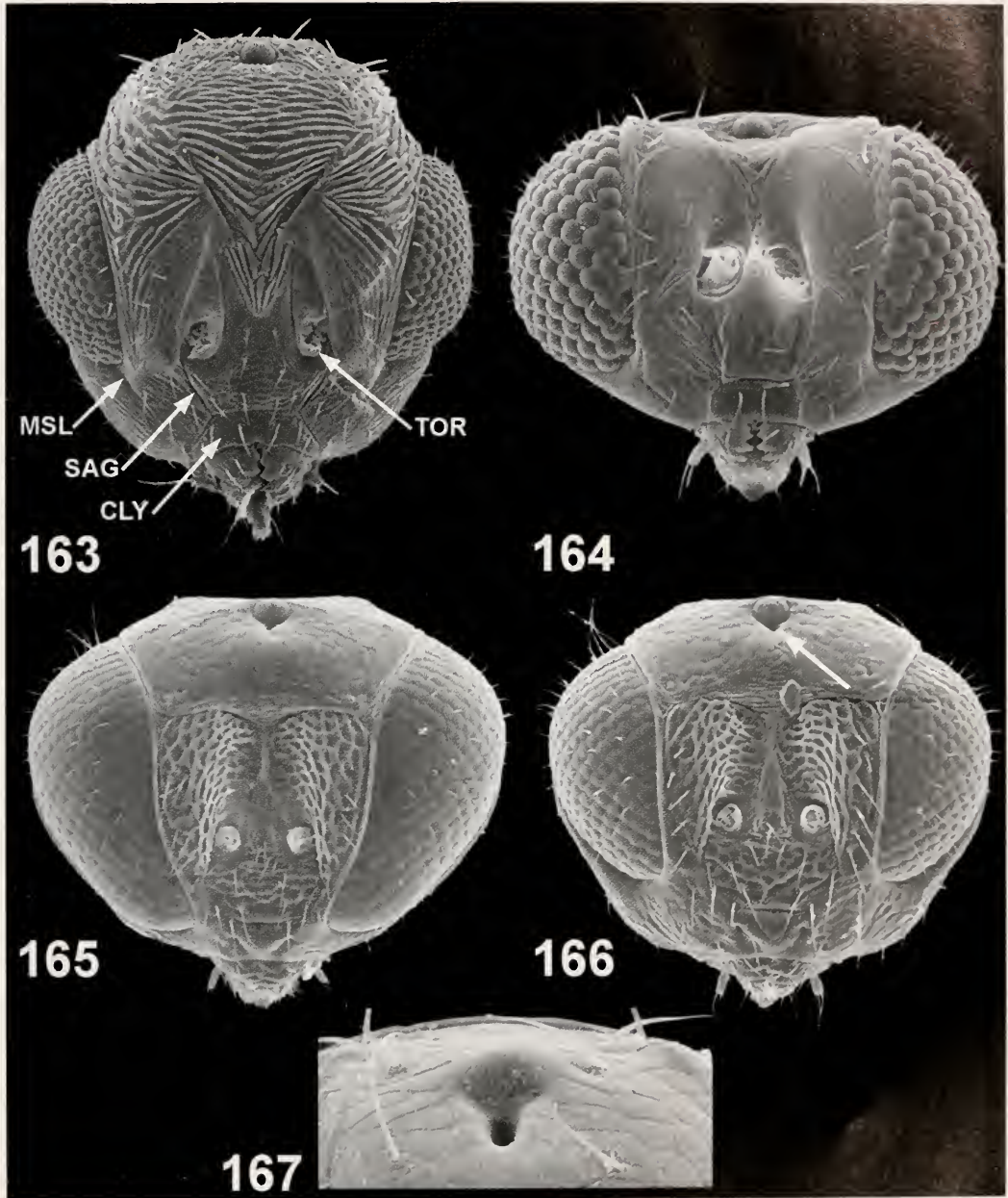


161

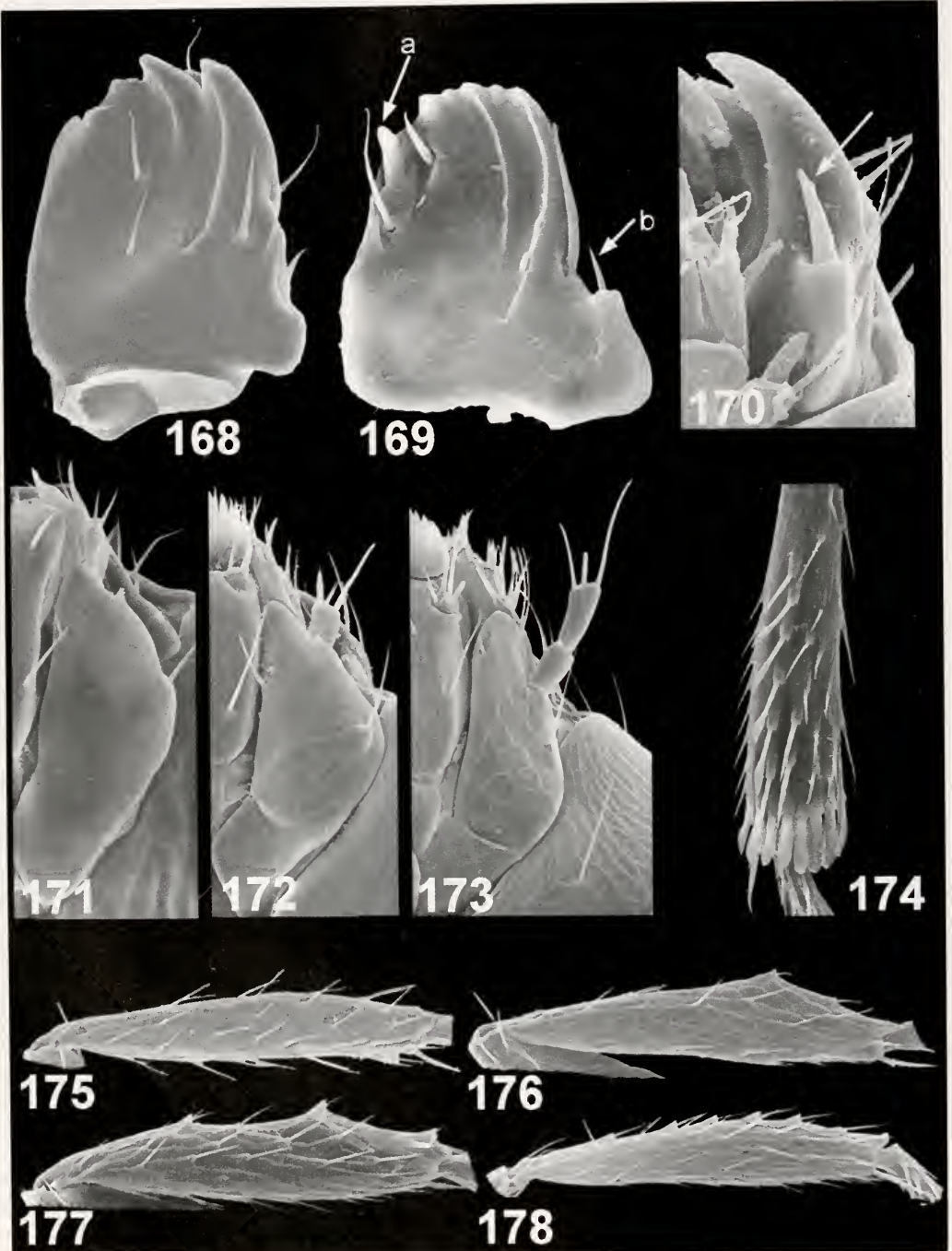


162

Figs 155–162. 155–157, fore wings. 155, *Sinepalpigramma longiciliatum*. 156, *Doirania elegans*. 157, *Pseudoligosita*. 158–162, fore wing venation (detail). 158, *Trichogramma* (arrow at campaniform sensilla at apex of premarginal vein). 159, *Aphelinoidea* (*Aphelinoidea*). 160, *Tumidifemur*. 161, *Burksiella spirita* (distance between 'a' and 'b' = distance from base of the marginal vein to the apex of the globose sensilla associated with the stigmal vein employed for the ratio  $SV + MV / PM$ . See Anatomical Structure and Terminology). 162, *Zaga*.

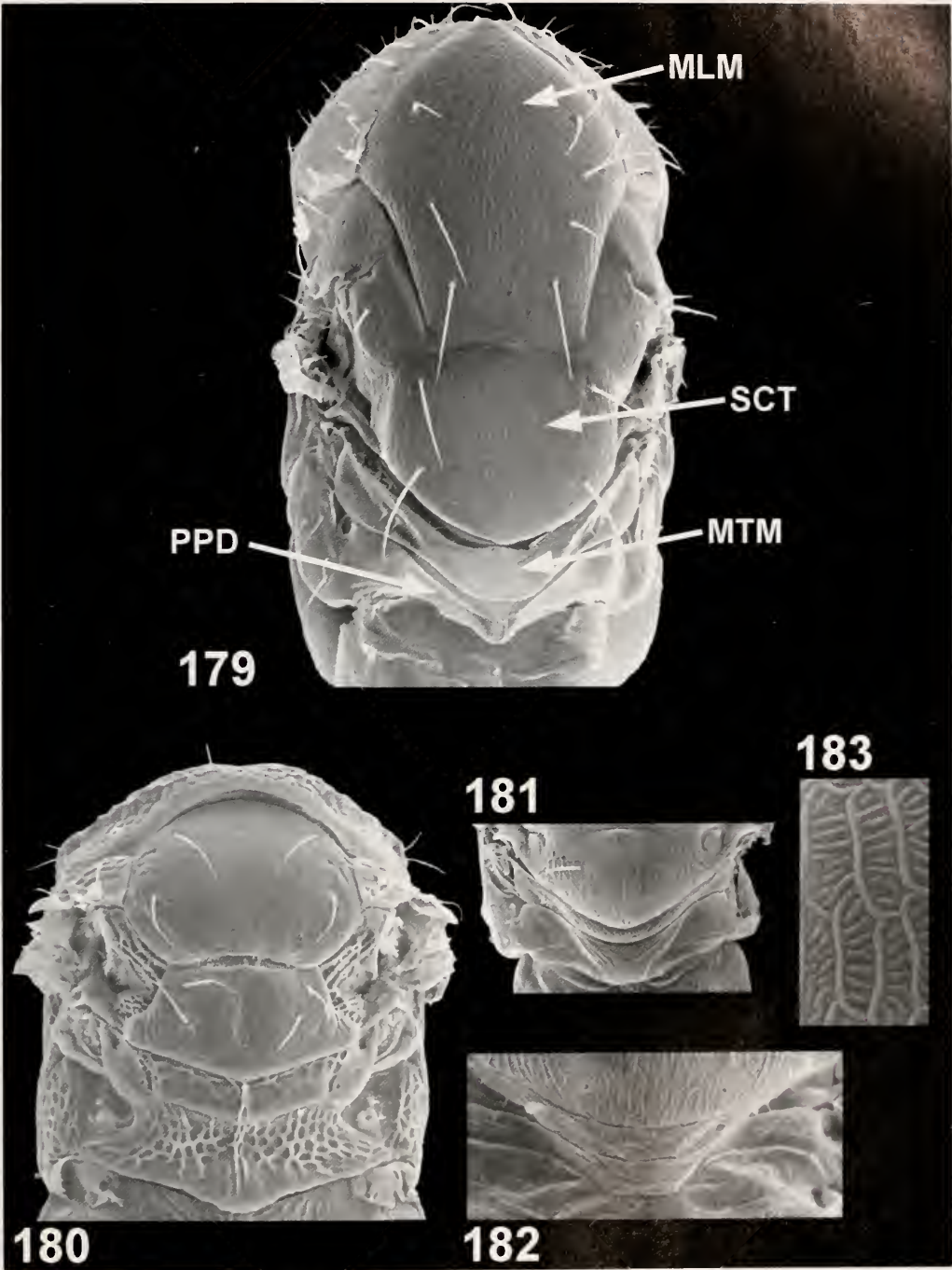


Figs 163–167. Head capsule. 163, *Aphelinoidea* (*Aphelinoidea*) [ See text (Anatomical Structure and Terminology) for explanation of acronyms]. 164, *Lathromeroidea exemphum* (♀) (Group B). 165, *Lathromeroidea gerriphaga* (♀) (Group C). 166, same (♂) (arrow at preocellar pit). 167, *Lathromeroidea* sp. (Group C), showing detail of preocellar pit anterior to medial ocellus).

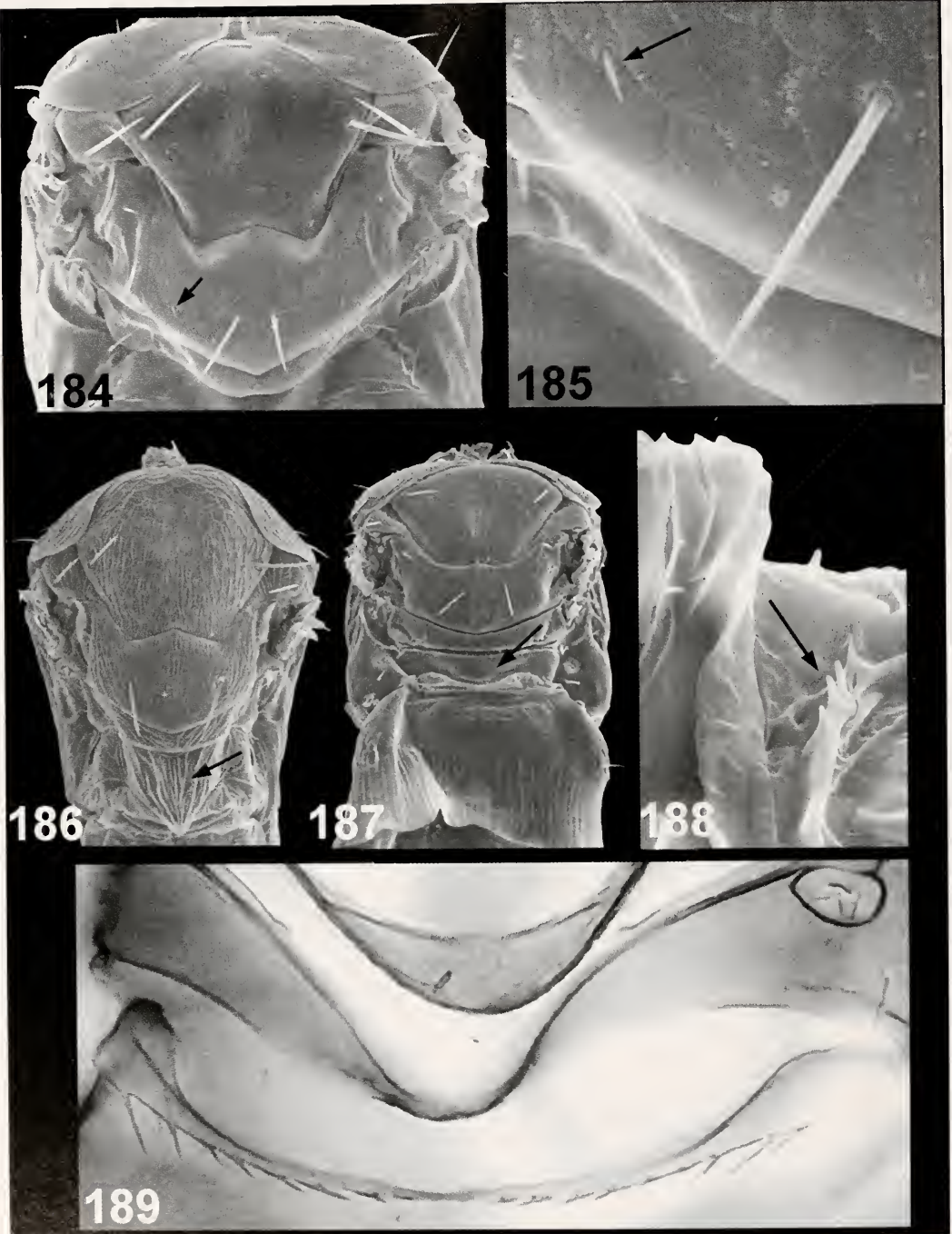


Figs 168–178. 168–170, mandibles (medial). 168, *Oligosita*. 169, *Trichogramma minutum* Riley ('a' to socketed anterior tooth; 'b' to posterior spine). 170, *Hydrophylita* (arrow to posterior spine). 171–173, maxillae (posterior). 171, *Sinepalpigrauma longiciliatum*. 172, *Oligosita*. 173, *Mirufens*. 174, Hind tibia (posterior), *Lathromeroidea exemplum*. 175–178, Fore tibia (dorsal surface above). 175, *Aphelinoidea*. 176, *Chaetostricha*. 177, *Zaga*. 178, *Mirufens*.



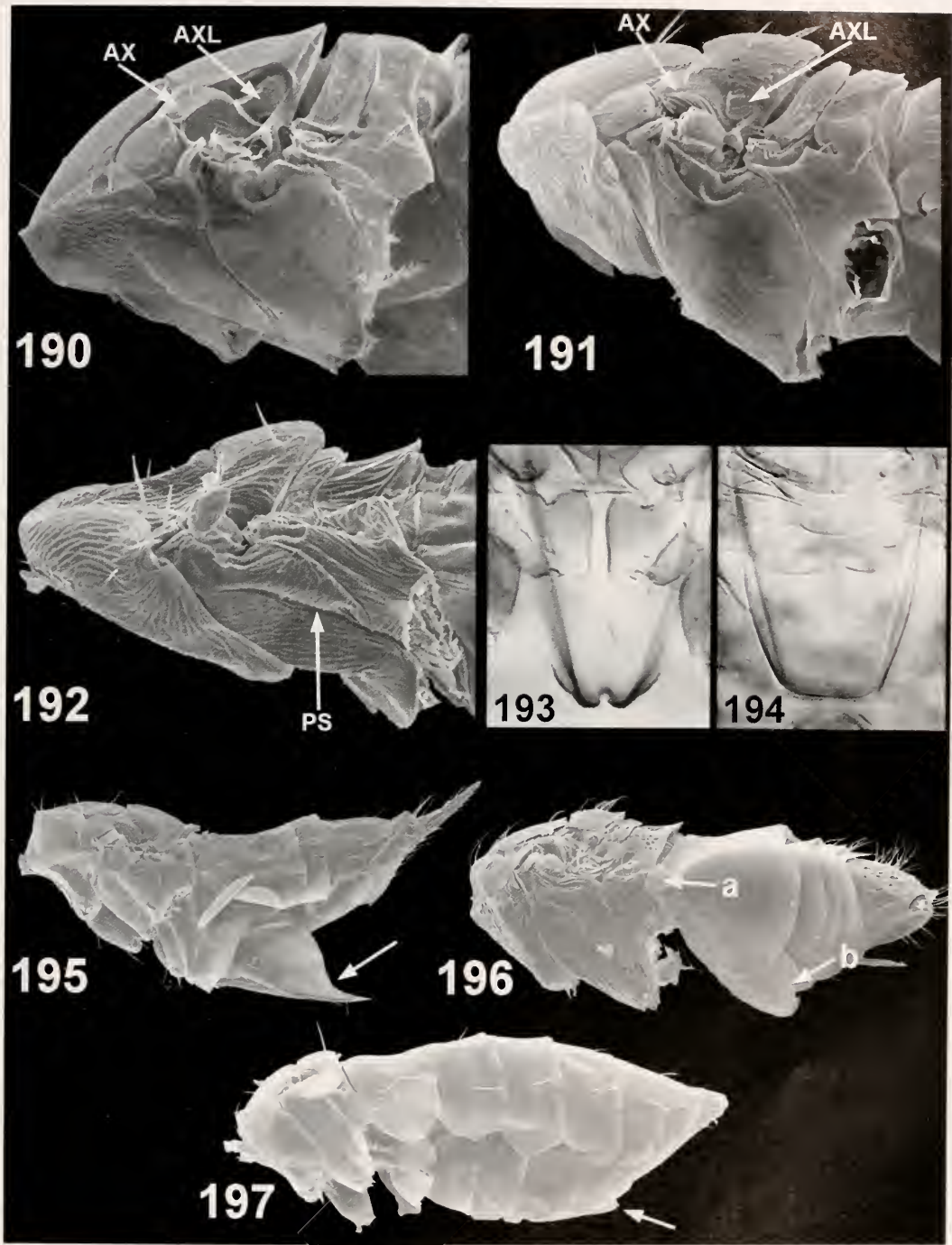


Figs 179–182. Mesosoma. 179, *Brachyufens osborni*. 180, *Lathromeroidea gerriphaga*, 181, *Lathromeroidea exemplum*. 182, *Uscanoidea*. 183, *Lathromeroidea exemplum* (sculpturing on midlobe). See text (Anatomical Structure and Terminology) for explanation of acronyms.



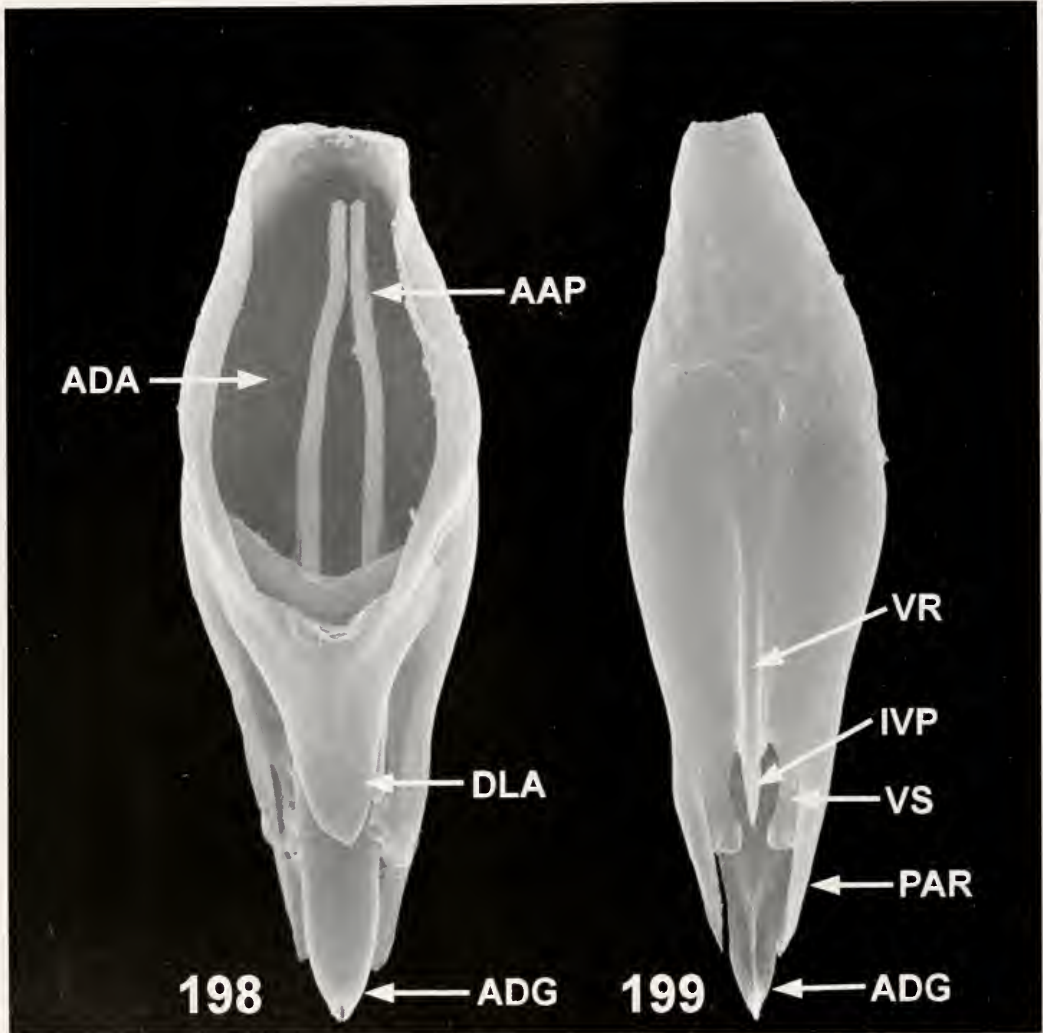
Figs 184–189. Mesosoma/Metasoma (anterior). 184, *Pintoa nearctica* (arrow to minute anterior scutellar seta). 185, same (detail of scutellum, arrow to minute anterior seta). 186, *Oligosita* (collina group, arrow to disk of propodeum). 187, *Pseudoligosita* (arrow to disk of propodeum). 188, *Paratrichogramma californica* (arrow to row of denticles on first metasomal tergum, SEM). 189, *Haeckeliaia* (row of denticles on first metasomal tergum at bottom, light microscope).



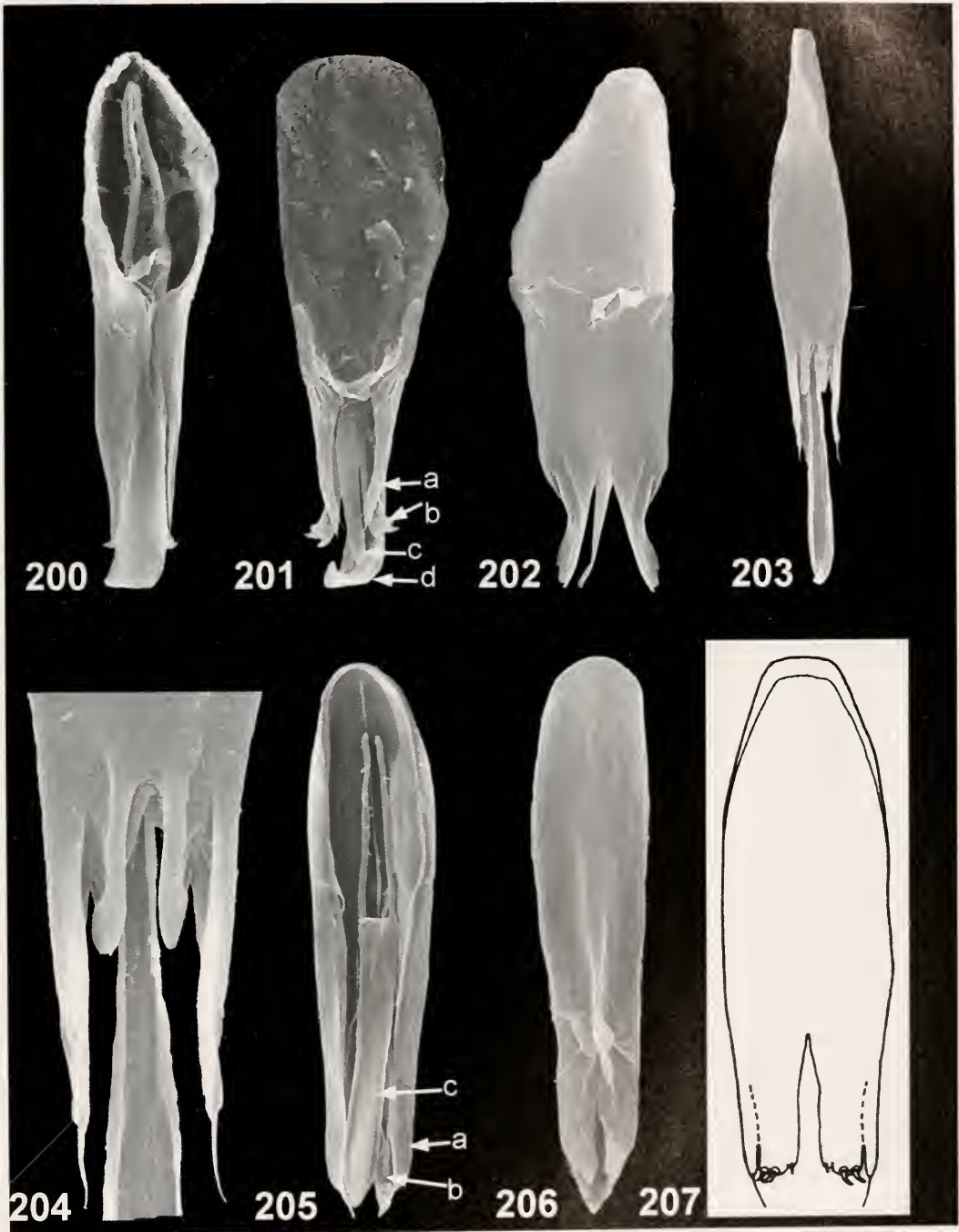


Figs 190–197. 190–192, mesosoma (lateral). 190, *Ceratogramma masneri*. 191, *Lathromeroidea exemplum*. 192, *Oligosita* (collina group; ps = mesopleural suture). 193–194, mesophragma. 193, *Chaetogramma occidentalis*. 194, *Trichogramma*. 195–197, full body (lateral). 195, *Xiphogramma fuscum* (arrow to hypopygium). 196, *Lathromeroidea gerriphaga* ('a' to anterolateral bulla on metasomal tergum II; 'b' to hypopygium). 197, *Pseudoligosita* (arrow to hypopygium).

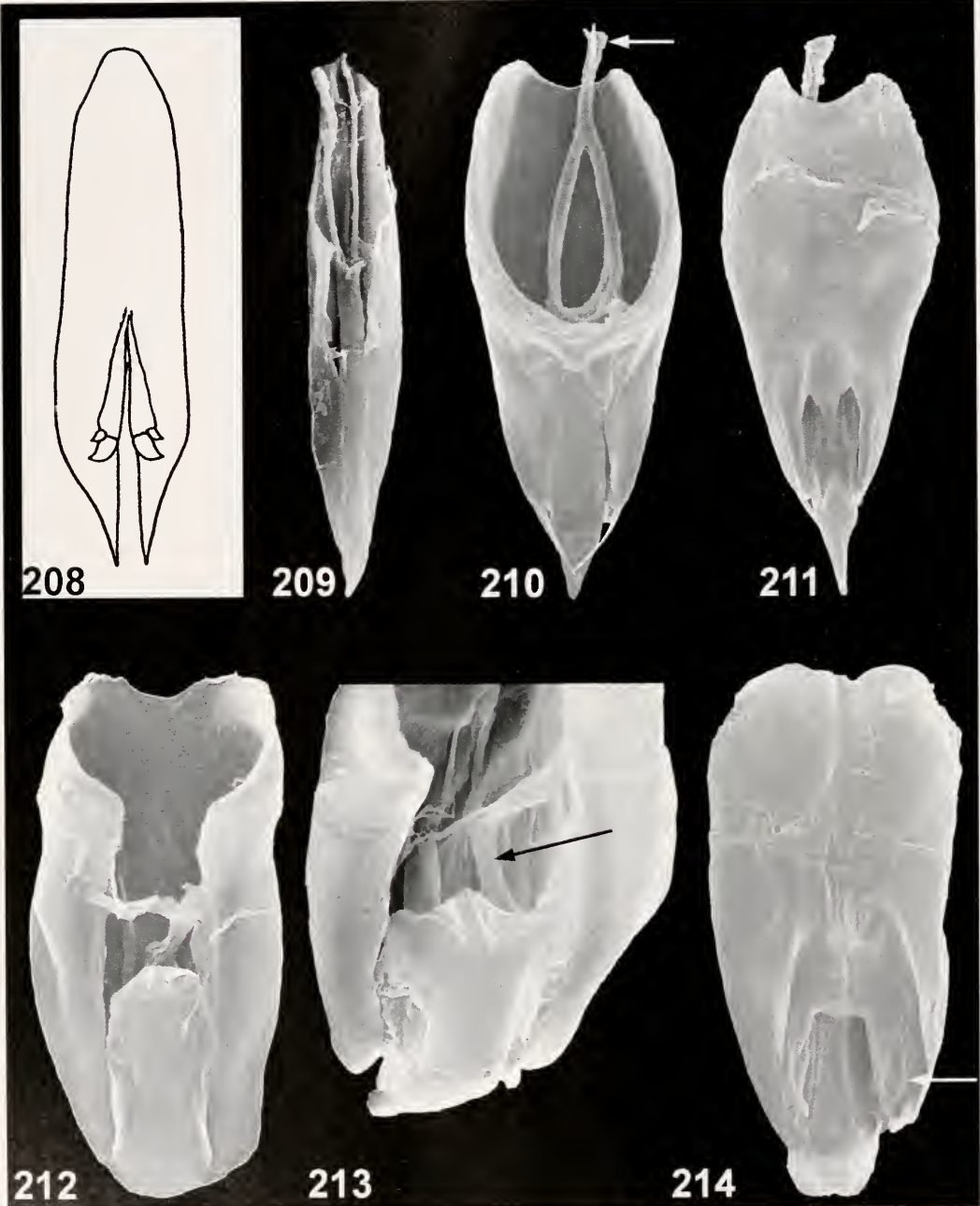




Figs 198–199. Male genitalia of *Trichogramma* sp. (labeled). 198, dorsal. 199, ventral. See text (Anatomical Structure and Terminology) for explanation of acronyms.

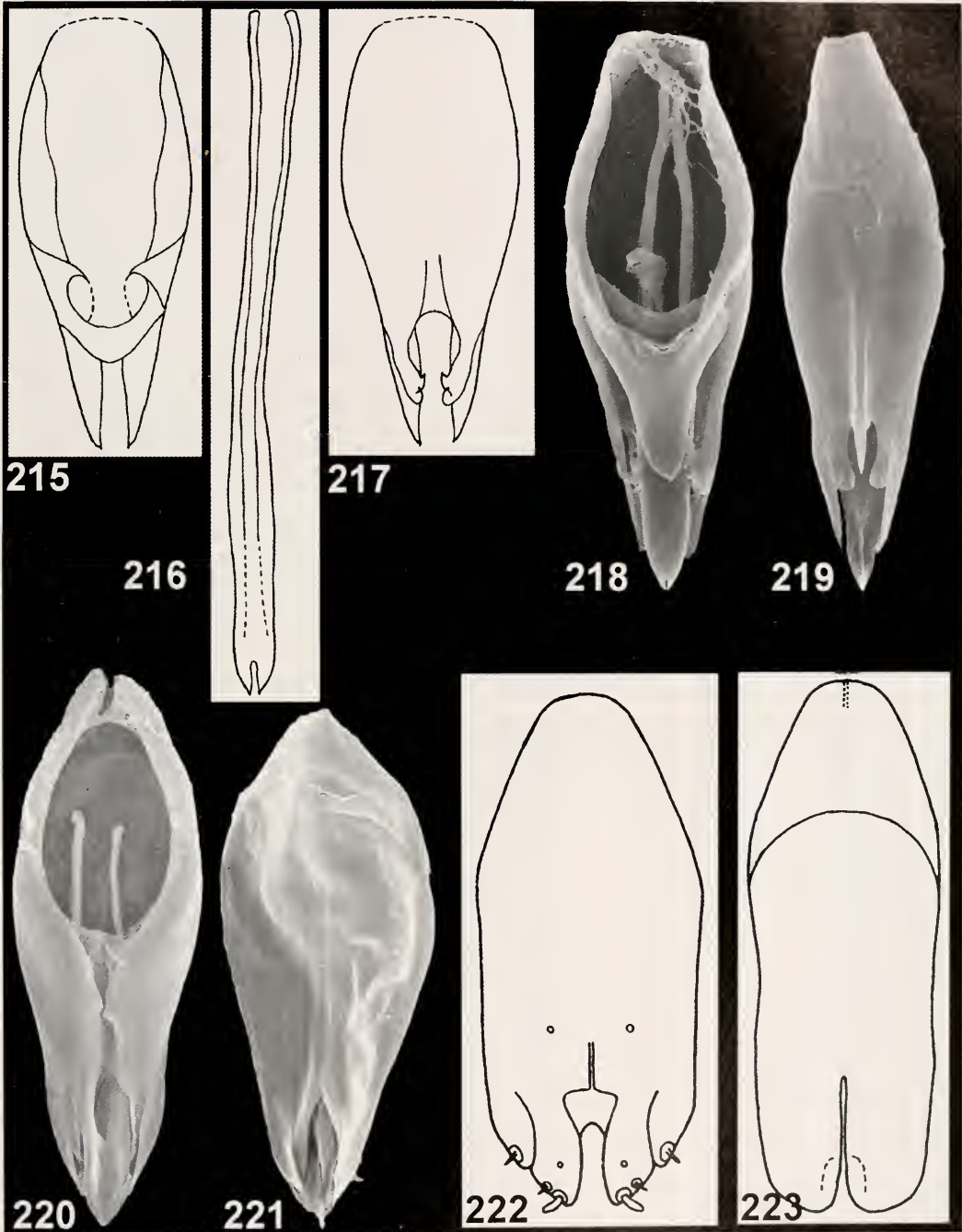


Figs 200–207. Male genitalia. 200, *Ceratogramma masneri* (dorsal). 201, same (ventral; 'a' to paramere, 'b' to volsella, 'c' to intervolsellar process, 'd' to aedeagus). 202, *Ceratogramma jeffersi* (ventral). 203, *Hydrophylita* (*Lutzimicron*) (ventral). 204, same (detail of apex). 205, *Mirufens* (dorsal; 'a' to paramere, 'b' to volsella, 'c' to aedeagus). 206, same (ventral). 207, *Pterandrophysalis levantina* (ventral).

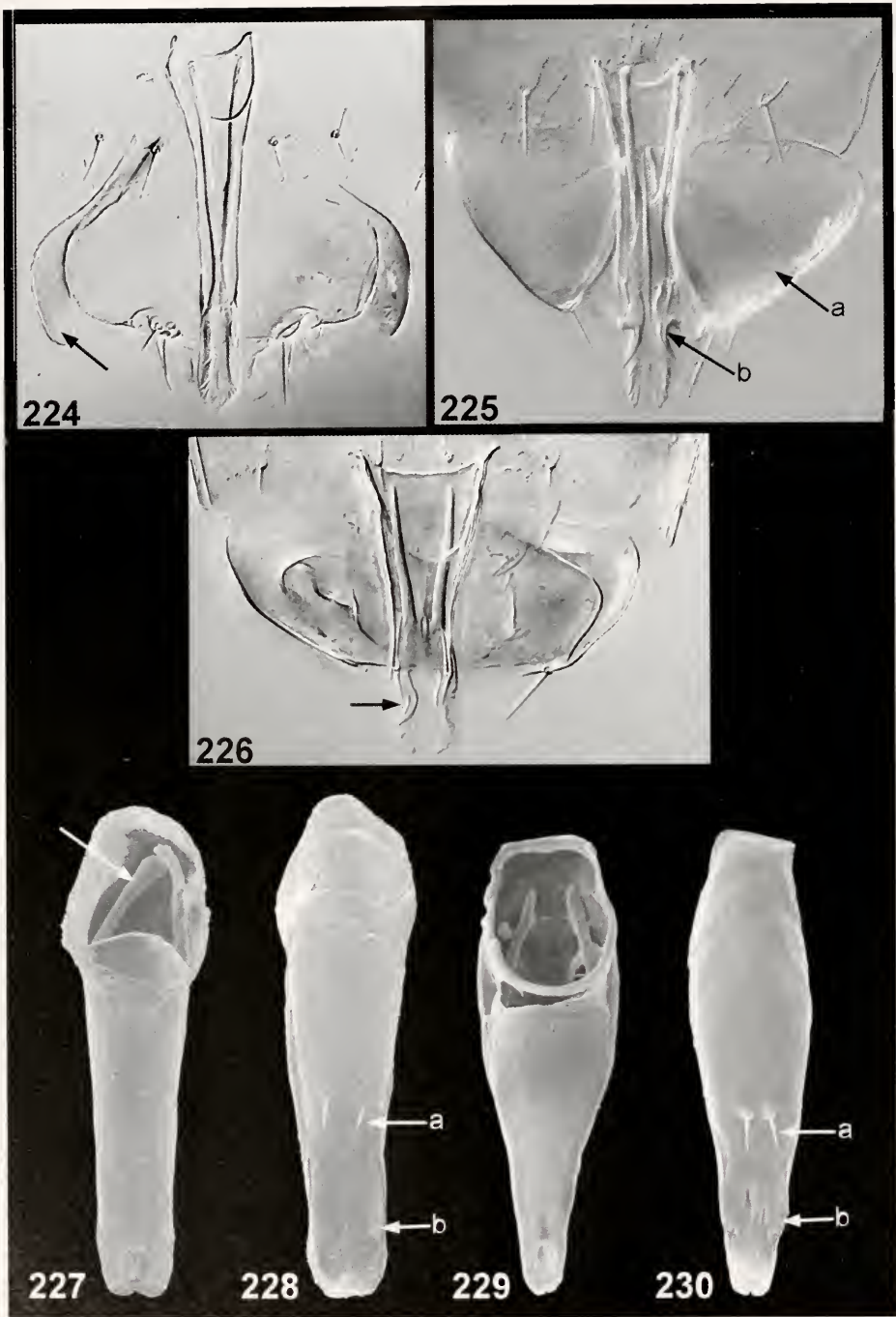


Figs 208–214. Male genitalia. 208, *Trichogrammatella* (ventral). 209, *Haeckeliania sperata* (dorsal). 210, *Paratrichogramma californica* (dorsal; arrow to basal fusion of aedeagal apodemes). 211, same (ventral). 212, *Soikiella occidentalis* (dorsal). 213, same (posterodorsal; arrow to aedeagal apodemes). 214, same (ventral; arrow to paramere – volsella hidden).

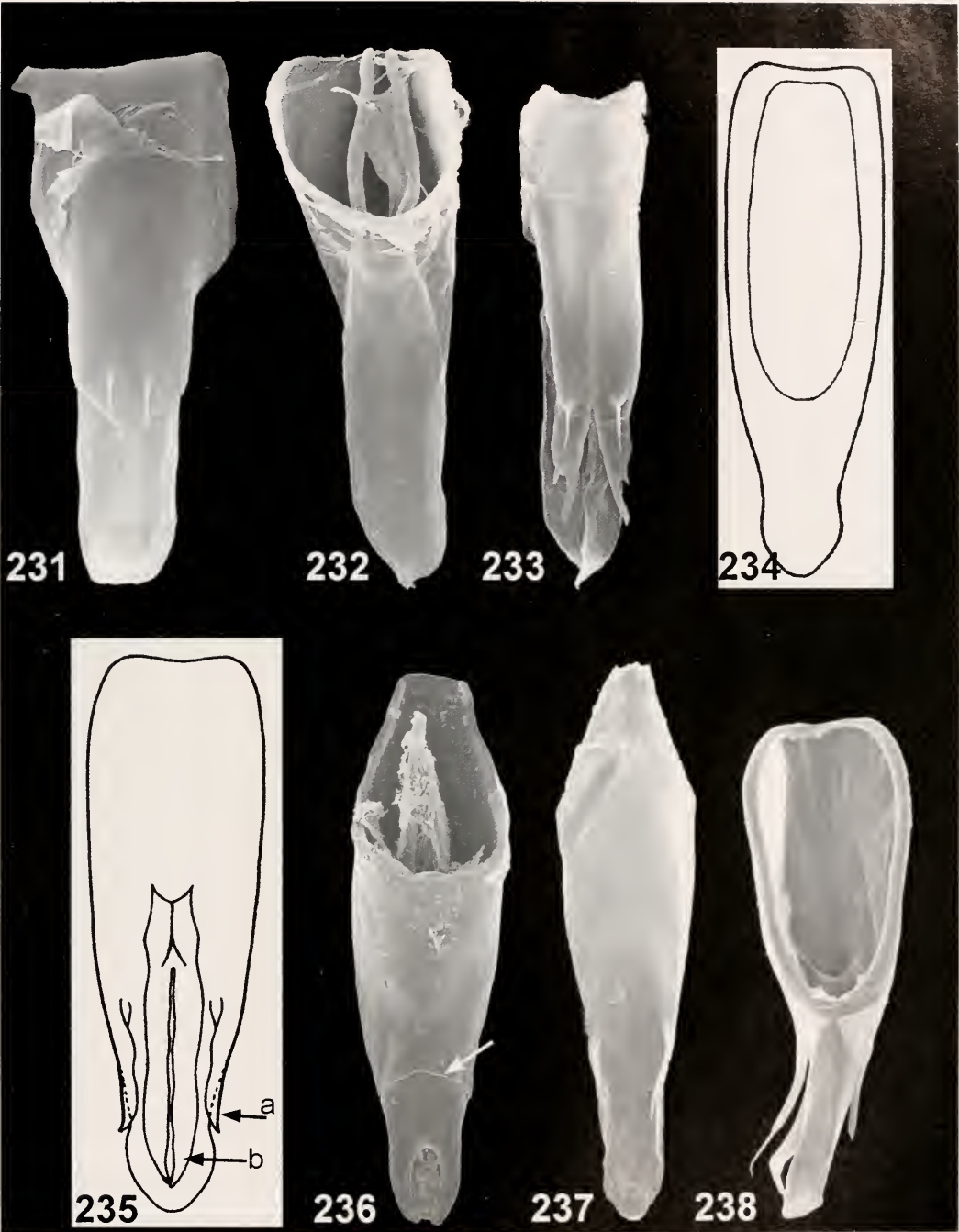




Figs 215–223. Male genitalia. 215, *Thanatogramma oweni* (dorsal; aedeagus removed). 216, same (aedeagus drawn to same scale as Figs 215 and 217). 217, same as 215 (ventral). 218, *Trichogramma* sp. (dorsal). 219, *Trichogramma* sp. (ventral). 220, *Trichogrammatoidea bactrae* (dorsal). 221, same (ventral). 222, *Trichogrammatomyia* (ventral). 223, *Xenufens ruskini* (ventral).

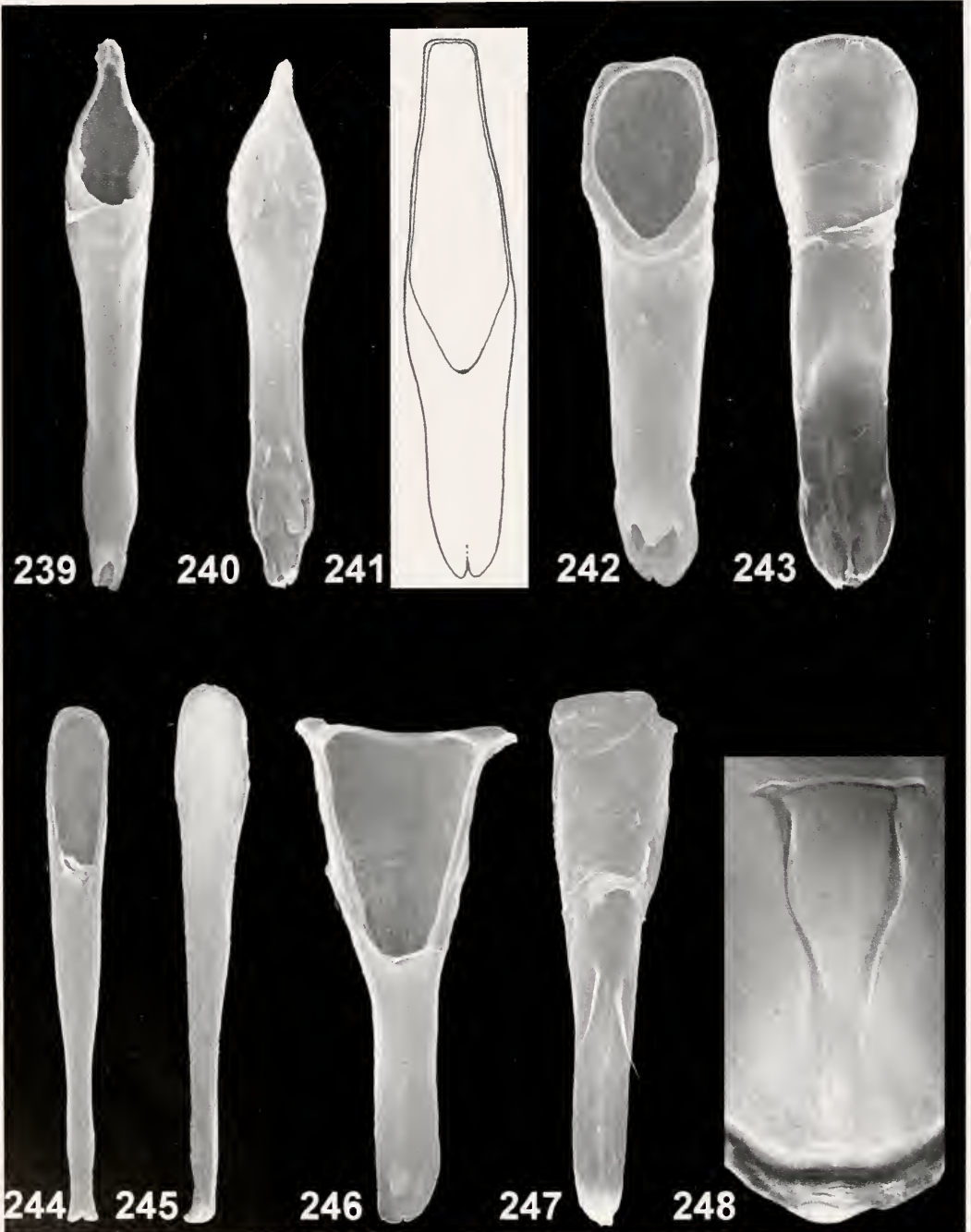


Figs 224–230. Male genitalia. 224, *Paracentrobia* (arrow to a strapshaped appendage of last metasomal sternum). 225, *Ittys* ('a' to a platform appendage of last metasomal sternum, 'b' to sickle shaped volsellus). 226, *Ittysella lagunera* (arrow to sickle shaped volsella). 227, *Aphelinoidea* (*plutella* group) (ventral; arrow to aedeagal apodeme). 228, same (ventral; 'a' to ventral seta, 'b' to volsella). 229, *Chaetogramma occidentalis* (dorsal). 230, same (ventral; 'a' to ventral seta, 'b' to volsella).



Figs 231–238. Male genitalia. 231, *Lathromeris hesperus* (ventral). 232, *Nicolavespa theresae* (dorsal). 233, same (ventral). 234, *Pseuduscana sola* (dorsal). 235, same (ventral; ‘a’ to paramere, ‘b’ to volsella). 236, *Tumidiclava* (dorsal; arrow to apparent demarcation line between capsule and aedeagus). 237, same (ventral; demarcation line on dorsal side not occurring ventrally). 238, *Ufens principalis* (dorsal).

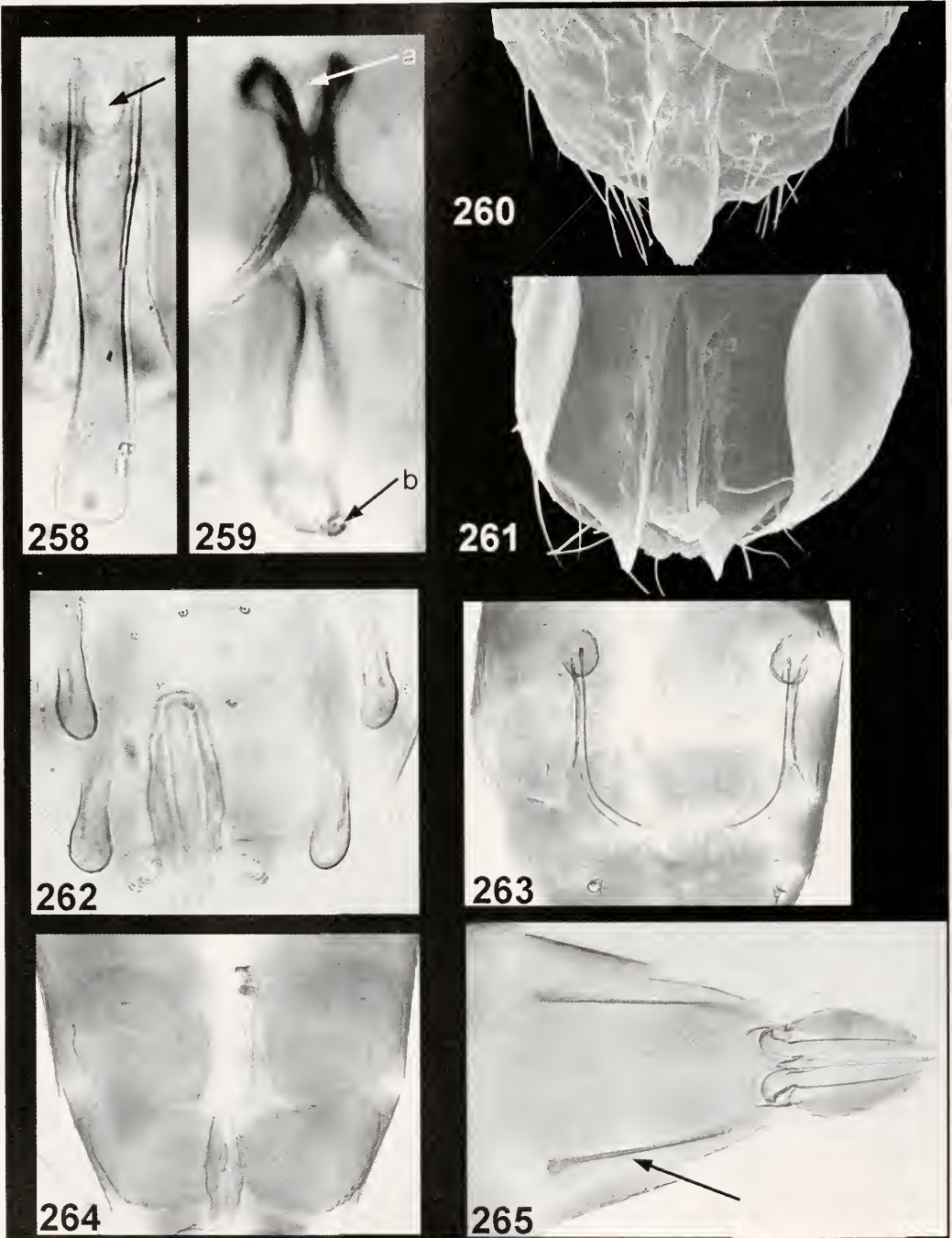




Figs 239–248. Male genitalia. 239, *Xiphogramma fuscum* (dorsal). 240, same (ventral). 241, *Adelogramma primum* (dorsal). 242, *Burksiella spirita* (dorsal). 243, same (ventral). 244, *Chaetostricha* (dorsal). 245, same (ventral). 246, *Lathromeroidea* (Group C) (dorsal). 247, same (ventral; base distorted). 248, *Lathromeroidea gerriphaga* (Group C) (dorsal).



Figs 249–257. Male genitalia. 249, *Lathromeroidea* (Group B) (ventral; arrow to ventral seta). 250, *Uscanoida* (ventral). 251, *Centrobiopsis odonatae* (ventral; note longitudinal furrow). 252, *Zaga* (dorsal). 253, same (ventral). 254, *Zagella* (dorsal; North American species). 255, same (ventral; arrow to ventral seta). 256, *Zagella* (ventral; South American species). 257, Same (detail of apex; arrow to paramere or volsella).

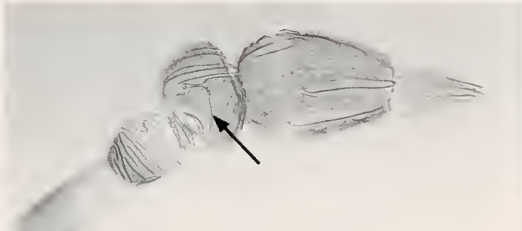


Figs 258–265. 258–259, male genitalia (Oligositini). 258, *Oligosita* (arrow to anterodorsal aperture). 259, *Pseudoligosita* (ventral; ‘a’ to anterodorsal aperture [note posteriorly directed apodemes below]; ‘b’ to apex of genitalia). 260–261, last sternal area in male. 260, *Zagella*. 261, *Lathromeroidea gerriphaga* (Group C). 252–264, dorsal metasomal modifications in *Lathromeris*. 262, *Lathromeris* sp. 1. 263, *Lathromeris hesperus*. 264, *Lathromeris* sp. 265, *Brachista fidae* (♀) (arrow to strut-like apodeme anterior to ovipositor)

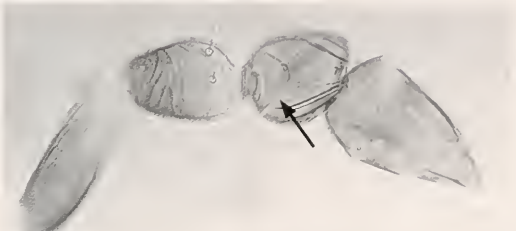




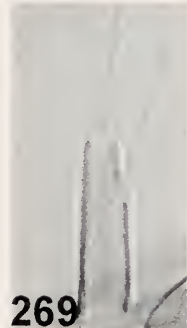
266



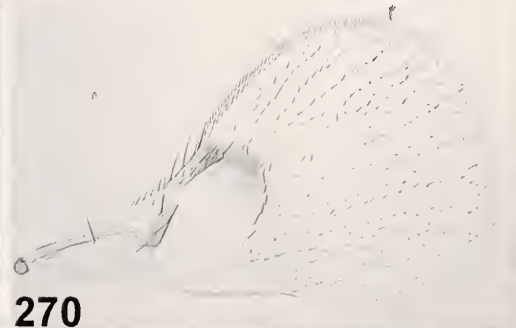
267



268



269



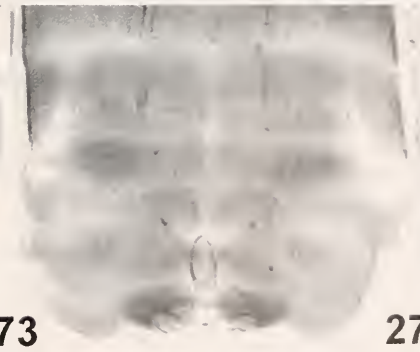
270



271



272



273



274

Figs 266–274. *Burksiella diana*. 266, habitus (♀). 267, antenna (♀) (arrow to suture between F1 and F2). 268, same (♂). 269, maxillary palp. 270, fore wing. 271, midlobe of mesoscutum showing sculpturing. 272, female metasoma. 273, male metasoma. 274, male genitalia (arrow to cuticular flange at base).

## Nomenclatural Changes in Old World Crabronidae (Hymenoptera), with Taxonomic Comments and New Distribution Records

WOJCIECH J. PULAWSKI

California Academy of Sciences, Golden Gate Park, San Francisco, California 94118, USA;  
email: wpulawski@calacademy.org

---

**Abstract.**—The following nominal species are newly synonymized (the valid names are listed last): *Cerceris insularis* F. Smith, 1856 = *Cerceris arenaria* (Linnaeus, 1758); *Oxybelus rufipes* Taschenberg, 1880 = *Oxybelus lamellatus* Olivier, 1811; *Tachytes astatifomis* Tsuneki, 1963 = *Tachytes pygmaeus* Kohl, 1888; *Tachytes decorsei* Berland, 1942, and *falciger* Arnold, 1951 = *Tachytes chudeaui* Berland, 1942; *Tachytes diversicornis* Turner, 1918, *niger* Berland, 1942, *senegalensis* Berland, 1942, *tassilicus* Pulawski, 1962, and *hengchunensis* Tsuneki, 1967 = *Tachytes xenoferus* Rohwer, 1911; *Tachytes eurous* Pulawski, 1962 = *Tachytes aeneus* Saunders, 1910; and *Tachytes rostratus* Berland, 1942 = *Tachytes basilicus* Guérin-Méneville, 1844. A new name, *Tachytes dogon*, is proposed for *Tachytes rufipes* Berland, 1942, a junior primary homonym of *Tachytes rufipes* Aichinger, 1870.

---

My fieldwork in various parts of the Old World, as well as visits to museums, revealed previously unnoticed synonymies, which are discussed below. The relevant types have been examined, except for that of *Oxybelus lamellatus* Olivier which is no longer in existence, for *Cerceris arenaria* Linnaeus whose identity has been firmly established (Richards 1935, Day, 1979), and for *Tachytes basilicus* Guérin-Méneville whose identity was confirmed by Pulawski (1962). The abbreviations used in the text for the institutional or personal collections that house these types or other specimens discussed are:

BMNH: The Natural History Museum, formerly British Museum (Natural History), London, United Kingdom  
CAS: California Academy of Sciences, San Francisco, California, USA  
CSE: Christian Schmid-Egger, Herrsching-Breitbrunn, Germany (personal collection)  
GENOVA: Museo Civico di Storia Naturale "Giacomo Doria", Genova, Italy

HALLE: Institut für Zoologie, Martin-Luther Universität Halle Wittenberg, Halle, Germany  
KOBÉ: Entomological Laboratory, Faculty of Agriculture, Kobe University, Rokko, Kobe, Japan  
MNHN: Muséum National d'Histoire Naturelle, Paris, France  
NHMW: Naturhistorisches Museum, Wien, Austria  
OXUM: Oxford University Museum of Natural History, Oxford, United Kingdom  
USNM: U.S. National Museum of Natural History, Smithsonian Institution, Washington, D.C., USA

### *Cerceris arenaria*

*Sphex arenaria* Linnaeus, 1758:571. Holotype: ♀, Sweden: no specific locality (Linnean Society, London). – Richards, 1935:169 (study of holotype); Day, 1979:50 (study of holotype).  
*Cerceris insularis* F. Smith, 1856:444, ♀. Holotype or syntypes: ♀, Italy: Sicily: no specific locality (BMNH), examined. **New synonym.** – Schletterer, 1887:441 (as tentative synonym of *Cerceris ferrerii*); Dalla Torre, 1897:460 (listed

as synonym of *Cerceris ferrerii*). – As *Cerceris flavilabris insularis*: Bohart and Menke, 1976:581 (listed); Pagliano, 1990:97 (in catalog of Italian Sphecidae).

The only specimen of Smith's *insularis* in the BMNH is a typical female of the common Palearctic species *arenaria*, with a distinctive clypeal lamella.

### *Oxybelus lamellatus* Olivier

*Oxybelus lamellatus* Olivier, 1811:595, sex not indicated. Syntypes: Egypt: no specific locality; and Iraq: Baghdad area (destroyed).

*Oxybelus rufipes* Taschenberg, 1880:781, ♀, ♂. Lectotype: ♀, Ethiopia: no specific locality (HALLE), present designation. New synonym.

I follow de Beaumont (1950:413) in his interpretation of *Oxybelus lamellatus*. The species is characterized by the following combination: mucro reddish brown, foliaceous, emarginate apically; postscutellum yellow between lamellae (except in many males), lamella divided apically; sternum II coarsely punctate except punctures contrastingly fine laterally; antennal flagellum and femora red; pygidial plate of female unusually broad; and male terga III–VI with conspicuous lateral spines. All these characters are found in the syntypes of *Oxybelus rufipes*.

### *Tachytes aeneus* Saunders

*Tachytes aeneus* Saunders, 1910:522, ♂ (as *aenea*, incorrect original termination). Syntypes: ♂, Algeria: Biskra (OXUM), one syntype examined before 1962. – Morice, 1911:99 (Algeria: Biskra); de Beaumont, 1955:172 (Morocco: Marrakech); Pulawski, 1962:421 (in revision of Palearctic *Tachytes*); R. Bohart and Menke, 1976:263 (listed).

*Tachytes eurous* Pulawski, 1962:423, ♀. Holotype: ♀, Israel: Eyn Aosh, now Hatzeva (originally H. Bytinski-Salz collection, now Tel Aviv University). **New synonym.** – de Beaumont, Bytinski-Salz and Pulawski, 1973:7 (Israel); R. Bohart and Menke, 1976:265 (listed).

I described *Tachytes eurous* from a single female from Israel, because I suspected it

may not be conspecific with the western North African *aeneus*, known only from the male. A recent study of topotypical females and males from both Morocco and Israel convinced me that only one species is involved. These two names are therefore synonyms.

*Tachytes aeneus* has a unique propodeal dorsum that has a triangular, ridged, glabrous area extending from base to apex (orientation of ridges varies from transverse to longitudinal). Also, the erect setae are all or largely absent on the scape, but present on tergum I. The female clypeus, with its free margin emarginate mesally and sharply pointed lip corner, is also distinctive. For additional characters, see Pulawski (1962:420).

**Material examined.** —ISRAEL: En Shahak in En Yahav Makhteshim Reserve at 30°42.8'N 35°11.1'E (1 ♀, 1 ♂, CAS; 1 ♂, CSE), Iddan in Arava Valley at 30°48.9'N 35°16.8'E (1 ♀, 2 ♂, CSE). MOROCCO: Marrakech (1 ♀, 1 ♂, CAS).

### *Tachytes basilicus* (Guérin-Ménéville)

*Lyrops basilicus* Guérin-Ménéville, 1844:440, ♀. Holotype: E, Senegal: no specific locality (GENOVA). – As *Tachytes basilicus*: F. Smith, 1856:300 (new combination, listed, spelled *basilica*); Pulawski, 1962:416 (full bibliography, synonymy, revision).

*Tachytes rostratus* Berland, 1942:6, ♂ (as *rostrata*, incorrect original termination). Holotype: ♂, Chad: Moyen Chari: Fort Archambault, now Sarh (MNHN), examined. **New synonym.**

The holotype of *rostratus*, a badly worn specimen with gastral pubescence matted by moisture, has all the distinctive characters of *basilicus* described by Pulawski (1962). I could not find any noteworthy differences when comparing it to specimens of *basilicus*.

The most important recognition features of *basilicus* are (Pulawski 1962): mouthparts elongate (in particular, galea markedly longer than scape and without transverse suture); clypeal free margin only slightly concave between lobe and eye orbit; hindfemur without apical lobe; pilosity



concealing integument at scutal forecorners; and gaster red at least basally, with appressed golden vestiture. In the female, the setae of the pygidial plate do not conceal the integument, and in the male the apical margin of sternum VIII is only slightly emarginate, almost entire.

### *Tachytes chudeaui* Berland

*Tachytes chudeaui* Berland, 1942:3, ♀ (as *Chudeaui*, incorrect original capitalization). Holotype: ♀, Mali: Niafunké near Toumbouctou (MNH), examined. – R. Bohart and Menke, 1976:264 (listed).

*Tachytes decorsei* Berland, 1942:7, ♂ (as *Decorsei*, incorrect original capitalization). Holotype: ♂, Mali: Douentza (MNH), examined. **New synonym.** – R. Bohart and Menke, 1976:264 (listed).

*Tachytes falciger* Arnold, 1951:152, ♂ (as *falcigera*, incorrect original termination). Holotype: ♂, Mauritania: Aleg (BMNH), examined. **New synonym.** – R. Bohart and Menke, 1976:265 (listed).

The species is a typical member of the *obsoletus* group as defined by Pulawski (1962). It can be recognized by the following characters: postocellar area narrow (least interocular distance equal  $1.1 \times$  length of flagellomere I in the female and  $0.9\text{--}1.4 \times$  in male), with erect setae and most punctures less than one diameter apart, apical lobe of hindfemur relatively large, as in *archaeophilus* Pulawski (see Figs 71 and 72 in Pulawski, 1962), hindfemoral venter without erect setae, tergum I with erect setae (only laterally in female and small males), femora and tibiae all black. Female: clypeal bevel rudimentary, terga I and II red (remainder black), tergum V with silvery pubescence laterally. Male: ventral margin of flagellomeres VIII and IX expanded (in many specimens also that of flagellomere X), gaster all black.

The species was previously known from Mauritania and Mali, but it also occurs in Burkina Faso and Niger.

*Material examined* (all CAS). —**BURKINA FASO:** Pala (1 ♂). **NIGER:** Agadez **Region:**

5 km N Agadez at 17°01.2'N 8°00.7'E (1 ♀, 16 ♂), 30 km S Agadez at 16°39.0'N 7°56.9'E (1 ♂). **Diffa Region:** 3 km N Diffa at 13°21.3'N 12°36.7'E (1 ♂), 8 km N Diffa at 13°24.1'N 12°36.2'E (3 ♀, 1 ♂), 54 km NE Diffa at 13°42.3'N 12°55.8'E (3 ♂), 87 km NE Diffa at 14°02.9'N 12°58.5'E (1 ♀), 14 km W Diffa at 13°15.8'N 12°29.0'E (2 ♂), 34 km SW Nguigmi at 13°58.8'N 12°58.2'E (1 ♀), 42 km SW Nguigmi at 13°54.5'N 12°56.5'E (4 ♀). **Dosso Region:** 13 km S Dosso at 12°56.6'N 3°11.0'E (3 ♀) 15 km N Gaya at 11°59.6'N 3°32.2'E (1 ♂). **Maradi Region:** 15 km NNW Maradi at 13°37.9'N 7°03.0'E (3 ♂), 17 km NNW Maradi at 13°38.7'N 7°02.6'E (1 ♂). **Tahoua Region:** Tahoua at 14°53.5'N 5°16.6'E (3 ♀). **Tillabéri Region:** 11 km N Ayorou at 14°49.3'N 0°52.2'E (2 ♂), 8 km SE Kollo at 13°16.4'N 2°22.0'E (1 ♀), Malalé 10 km E Niamey at 13°27.1'N 2°10.4'E (1 ♀), 21 km N Niamey at 13°33.2'N 2°21.5'E (3 ♀), 63 km NW Niamey at 13°53.4'N 1°35.2'E (1 ♂), 82 km ESE Téra at 13°51.1'N 1°31.3'E (2 ♂), 15 km NW Tillabéri at 14°17.3'N 1°20.5'E (1 ♀, 1 ♂). **Zinder Region:** 21 km W Gouré at 13°51.2'N 10°07.8'E (1 ♀), 3 km S Takiéta at 13°39.6'N 8°30.7'E (1 ♂), 6 km S Takiéta at 13°37.1'N 8°30.6'E (1 ♂), 45 km S Tanout at 14°37.4'N 8°44.3'E (1 ♂).

### *Tachytes dogon* Pulawski, new name

*Tachytes chudeaui* var. *rufipes* Berland, 1942, ♀, ♂ (♀ = *Tachytes saharicus*), junior primary homonym of *Tachytes rufipes* Aichinger, 1870, which is a junior synonym of *Tachysphex brullii* (F. Smith, 1856). Lectotype: ♂, Mali: Douentza (MNH), designated by Pulawski, 1962:385, reexamined in 2005. – As *Tachytes rufipes*: Pulawski, 1962:385 (new status).

Named after the Dogon people of Mali.

This species can be recognized by the following characteristics. Galea shorter than scape, female clypeus noncarinate and apical depression of sternum II impunctate, male forecoxa and foretrochanter not modified. The following are red: scape, flagellum partly, femora, tibiae, and tarsi; wings yellow, infumate along distal margin (infumate portion wears off in old specimens); gaster at least partly red. Hindfemur without apical lobe at apicov-

entral angle of outer side (see Figure 73J in Bohart and Menke, 1976, for lobe present). In female, punctures of pygidial plate markedly more spaced than average in genus, especially anterolaterally (integument easily visible between the setae except posteriorly). In male, width of postocellar area (= least interocular distance) about equal to midocellar width; midbasitarsal venter evenly curved except somewhat expanded apically, without spines; apex of sternum VIII only slightly emarginate (markedly less than average for the genus). Hindfemoral venter with no erect setae in female and many males, but a few suberect setae present on basal half in some males (setal length no greater than midocellar width).

*Material examined* (all CAS): **MALI:** 10 km E Mopti (4 ♀, 10 ♂). **NIGER:** **Diffa Region:** 42 km SW Nguigmi at 13°54.5'N 12°56.5'E (1 ♂). **Tillabéri Region:** 11 km N Ayorou at 14°49.3'N 0°52.2'E (1 ♂), 82 km ESE Téra at 13°51.1'N 1°31.3'E (2 ♂). **Zinder Region:** 19 km E Gouré at 13°52.6'N 10°24.9'E (1 ♂), 27 km W Guidiguir at 13°40.9'N 9°39.1'E (2 ♂), 29 km NW Magaria at 13°09.1'N 8°41.3'E (1 ♂), 3 km S Takiéta at 13°39.6'N 8°30.7'E (6 ♂), 45 km S Tanout at 14°37.4'N 8°44.3'E (1 ♂).

### *Tachytes pygmaeus* Kohl

*Tachytes pygmaea* Kohl, 1888:134, ♀, ♂ (♂ = *Tachytes argyreus* F. Smith), incorrect original termination. Lectotype: ♀, Egypt: no specific locality (NHMW), designated by Pulawski, 1962:465.

*Tachytes astatiformis* Tsuneki, 1963:6, ♂. Holotype: ♂, Thailand: Chiangmai (KOB), examined. **New synonym.** – R. Bohart and Menke, 1976:236 (listed).

*Tachytes pygmaeus* is easily recognized by its glabrous propodeal dorsum combined with an emarginate posterior mandibular margin and the propodeal spiracle separated from the postnotum by less than its own length. *Tachytes dichrous* F. Smith is the only other member of the genus with an entirely asetose propodeal dorsum. Unlike *pygmaeus*, the mandibular posterior

margin of *dichrous* is not emarginate, and the propodeal spiracle is separated from the postnotum by more than its own length, among other characters.

Pulawski (1962:465) gave Egypt, Morocco, and Sudan as the geographic distribution of *pygmaeus*, but Bohart and Menke (1976:266) correctly listed it from all of Africa, India, and Sri Lanka. The new synonymy extends its range to Thailand.

### *Tachytes xenoferus* Rohwer

*Tachytes xenoferus* Rohwer, 1911:581, ♀, ♂. Holotype: ♂, India: Gujarat: Deesa (USNM), examined.

*Tachytes diversicornis* R. Turner, 1918:94, ♂, ♀. Lectotype: ♂, Pakistan: Karachi (BMNH), designated by Pulawski, 1975a:316, examined. **New synonym.**

*Tachytes Chudeaui* var. *niger* Berland, 1942:4, ♀ (as *nigra*, incorrect original termination). Holotype: ♀, (Mali?): Middle Niger basin: Siganara (MNHN), reexamined in 2005. **New synonym.** – As *Tachytes niger*: Pulawski, 1962:402 (new status). – As *Tachytes chudeaui niger*: Bohart and Menke, 1976:264 (new status, listed).

*Tachytes senegalensis* Berland, 1942:9, ♂. Holotype: ♂, Mali: Kayes (MNHN), examined in 2005. **New synonym.**

*Tachytes tassilicus* Pulawski, 1962:401, ♂. Holotype: Algeria: Djanet (MNHN), reexamined in 1991. **New synonym.**

*Tachytes hengchunensis* Tsuneki, 1967:47, ♀, ♂. Holotype: E, Taiwan: Pingtung County: Hengchun (originally K. Tsuneki coll., now USNM), examined in 2005. **New synonym.** – Haneda, 1971:30 (Taiwan); Tsuneki, 1971:8 (Taiwan); Haneda, 1972:4 (Taiwan; as *fengchunensis*); Murota, 1973:118 (Taiwan); R. Bohart and Menke, 1976:265 (listed); Tsuneki, 1977:269 (Taiwan); Nuhn and Menke, 1994:25 (holotype transferred to USNM); Porter, Stange, and Wang, 1999:8 (in checklist of Sphecidae of Taiwan).

*Tachytes xenoferus* is a member of the *maculicornis* group as defined by Pulawski, 1962:390. It is characterized by an all black gaster and the absence of erect setae on the midfemoral venter (erect setae may be present or absent on sternum II). Other

characters include: mouthparts short (galea shorter than scape), propodeal dorsum and side not ridged, female clypeus not carinate, apical depression of sternum II impunctate, and pygidial plate somewhat acute apically, male forecoxa and foretrochanter not modified. Both sexes can be recognized from similar species by midtarsomere III slightly shorter than II (rather than equal in length).

The male of *Tachytes xenoferus* is characterized by the midbasitarsus expanded apically, midtarsomere II not modified, sternum VIII with usual, short setae, most or all of the clypeal bevel densely punctate (punctures less than one diameter apart or nearly so), and in many specimens middle flagellomeres yellowish to a various degree. These characteristics are shared by the male of *diversicornis*, which clearly is a junior synonym. The hindfemur is minimally concave basoventrally in many specimens (including the holotypes of *xenoferus* and *diversicornis*). Also, flagellomeres IX and X are only minimally expanded apicoventrally (in the holotype of *xenoferus*, a stylopized specimen, only flagellomeres I and II are preserved on one antenna, and I-VI on the other). The other species in which the male has an apically expanded apex of midbasitarsus differ from *xenoferus* as follows (in addition to the midtarsomeres II and III). In *argenteus* Gussakovskij, the clypeal bevel has only a few, sparse punctures. In *flagellarius* Nurse, flagellomeres IV-X are markedly expanded ventrally and the hindfemur is markedly concave basoventrally. In *maculicornis* E. Saunders, flagellomeres III-VII are roundly expanded ventrally, the hindfemur is markedly concave basoventrally, and midtarsomere II is asymmetrical, with apex expanded anteroventrally. In *sacricola* Pulawski, the hindfemur is markedly concave basoventrally and midtarsomere II is asymmetrical, with apex expanded anteroventrally. Finally, in *trichopygus* Pulawski (female unknown), setae of sternum

VIII are conspicuously elongate (apical setae  $3 \times$  midocellar diameter).

I described *Tachytes tassilicus* from a single male and I thought that it differed from *diversicornis* (i. e., *xenoferus*) in having the hindfemoral venter not concave basally and the thoracic setae golden (contrasting with gastral setae). A study of additional material convinced me that these differences do not stand scrutiny. In fact, the hindfemoral venter varies from slightly concave to entire, and the thoracic vestiture may be silvery in specimens with nonconcave hindfemoral venter, and golden in specimens with a slightly concave venter. Clearly, these two names are synonyms (as well as synonyms of *xenoferus*). The holotype of *Tachytes senegalensis* is identical to *tassilicus* and is therefore another synonym of *xenoferus*.

Specimens from Niger vary markedly in color. In most, the femora and the tibiae are black. In several females, however, part of the forefemur and the mid- and hindfemora are red, and in some all the femora are red. In several males, all the tibiae and the hindfemur are red (the hindfemur may be black basally), and in some also a part of the midfemur is red.

I thought (Pulawski, 1962:403) that *Tachytes niger* Berland was an invalid junior homonym of *Tachytes niger* Vander Linden, 1829. This opinion was incorrect, as Vander Linden (1829) did not describe the species, but transferred to *Tachytes* the species *Sphex niger* Fabricius, 1775 (which is currently placed in *Liris*, see International Commission on Zoological Nomenclature, 1973, Opinion 997).

*Tachytes xenoferus* was described from the Gujarat State of India, while Pulawski (1962:401) listed it (as *diversicornis*) from Pakistan, Israel, Egypt, and Sudan, and Bohart and Menke (1976:264) added Ghana, Ethiopia, and Mali. I collected the species in Burkina Faso, Niger, and Oman, and I examined specimens from Saudi Arabia, India, Sri Lanka, Thailand, and Taiwan.



*Material examined* (all CAS): **BURKINA FASO**: 36 km NE Bobo Dioulasso at 11°23.3'N 4°04.3'W (2 ♀, 1 ♂), 71 km NNW Bobo Dioulasso at 11°42.0'N 4°31.4'W (2 ♂), 28 km NE Dédougou at 12°35.5'N 3°15.6'W (2 ♀), 38 km SSW Dédougou at 12°10.5'N 3°36.5'W (5 ♂), 10 km E Dori 14°00.5'N 0°03.2'E (1 ♂), 39 km E Dori 13°58.1'N 0°17.5'E (1 ♂), 4 km NE Dori at 14°03.8'N 0°03.1'E (2 ♀, 3 ♂), 15 km S Gorom Gorom at 14°21.4'N 0°07.9'E (2 ♀, 15 ♂), 36 km E Koudougou at 12°12.0'N 2°01.6'W (1 ♀), 69 km W Koudougou at 12°14.8'N 2°57.7'W (1 ♀), 17 km S Koupela at 12°02.2'N 0°21.8'E (1 ♀, 1 ♂), 80 km S Ouagadougou at 11°40.9'N 1°14.2'W (1 ♂), 13 km NE Ouahigouya at 13°38.9'N 2°19.6'W (1 ♂), 4 km NW Ouahigouya at 13°37.0'N 2°27.6'W (2 ♀, 12 ♂), 15 km SSE Ouahigouya at 13°27.0'N 2°22.9'W (1 ♂), 52 km SSE Ouahigouya at 13°07.3'N 2°20.8'W (1 ♂), 2 km W Pô, 11°11.0'N 1°09.5'W (3 ♂). **INDIA: Pondichery Territory**: Karikal (4 ♂). **Tamil Nadu**: Coimbatore (1 ♀). **NIGER: Agadez Region**: 0.5 km SE Aderbissinat at 15°36.9'N 7°54.0' E (1 ♀), 5 km N Agadez at 17°01.2'N 8°00.7'E (1 ♀, 6 ♂). **Dosso Region**: 13 km S Dosso at 12°56.6'N 3°11.0'E (1 ♂), 39 km S Dosso 12°40.1'N 3°10.6'E (6 ♂), 15 km N Gaya at 11°59.6'N 3°32.2'E (1 ♀, 1 ♂). **Maradi Region**: 23 km NNW Maradi at 13°42.3'N 7°01.4'E (1 ♂). **Niamey Region**: 8 km NW Niamey at 13°35'N 1°59.9'E (2 ♀, 1 ♂). **Tillabéri Region**: 13 km N Ayorou at 14°50.1'N 0°52.4'E (1 ♀, 2 ♂), 2 km SE Kollo at 13°19.6'N 2°19.9'E (1 ♀, 1 ♂), Malalé 10 km E Niamey at 13°27.1'N 2°10.4'E (1 ♀, ♂), 13 km N Niamey at 13°32.6'N 2°16.4'E (1 ♀), 15 km NW Tillabéri at 14°17.3'N 1°20.5'E (1 ♂), 30 km SSW Torodi at 12°49.5'N (1 ♀). **Zinder Region**: Bosotchouwa 20 km SW Takiéta at 13°30.1'N 8°31.9'E (1 ♂), 49 km SW Dengas at 12°52.8'N 8°58.6'E (1 ♀), 18 km N Gouré at 14°08.7'N 10°11.6'E (1 ♀, 1 ♂), 21 km W Gouré at 13°51.2'N 10°07.8'E (1 ♀), 23 km NNW Maradi at 13°42.3'N 7°01.4'E (1 ♀), 3 km S Takiéta at 13°39.6'N 8°30.7'E (3 ♀, 1 ♂), 6 km S Takiéta at 13°37.1'N 8°30.6'E (1 ♀), 31 km NW Tanout at 15°05.6'N 8°36.1'E (1 ♂), 11 km S Tanout at 14°52.6'N 8°52.3'E (1 ♀), 18 km S Tanout at 14°48.3'N 8°51.9'E (1 ♂), 37 km S Tanout at 14°38.2'N 8°42.6'E (2 ♂), 45 km S Tanout at 14°37.4'N 8°44.3'E (1 ♀), 55 km S Tanout 14°31.2'N 8°44.3'E (1 ♂), 44 km N Zinder 14°12.9'N 8°49.3'E (1 ♀, 1 ♂), 52 km N Zinder at 14°17.2'N 8°46.9'E (1 ♀), 37 km S Zinder at

14°13.3'N 9°00.5'E (4 ♀, 2 ♂), 45 km S Zinder at 13°27.3'N 9°00.5'E (1 ♂). **OMAN**: Wadi Ghul near Nizwa at 22°53.0'N 57°31.2'E (1 ♀). **SAUDI ARABIA**: El Riyadh (2 ♀, 5 ♂), Haddat Ash Sham (1 ♀). **SRI LANKA: Colombo District**: Ratmalana (1 ♀). **Mannar District**: Kokmotte Bungalow 0.5 mi. NE Wilpattu (1 ♂). **TAIWAN: Pingtung Shih (county)**: Kentin (1 ♂), Manchou (1 ♀, 1 ♂). **Taitung Shih**: Tulan (1 ♀). **Shih unknown**: Anping (1 ♂), Taihorin (1 ♀). **THAILAND: Songkhla Province**: Hat Yai (1 ♀).

## ACKNOWLEDGMENTS

I sincerely thank the museum curators who sent material for study: M. Dorn (Halle, Germany), Lorraine Ficken (London, United Kingdom), Ted Schulz and the late Karl V. Krombein (Washington, D.C., USA), Tikhiko Naiko (Kobe, Japan), and Claire Villemant (Paris, France). Jere S. Schweikert and Arnold S. Menke kindly reviewed earlier drafts of the manuscript.

## LITERATURE CITED

- Arnold, G. 1951. Sphecidae and Pompilidae (Hymenoptera) collected by Mr. K.M. Guichard in West Africa and Ethiopia. *Bulletin of the British Museum (Natural History). Entomology* 2: 95–183.
- Berland, L. 1942. Les *Tachytes* africains des collections du Muséum (Hymenopt. Sphegidae). *Revue Française d'Entomologie* 9: 1–10.
- Bohart, R. M., and A. S. Menke. 1976. *Sphecid Wasps of the World. A generic revision*. University of California Press, Berkeley, Los Angeles, London. 1 color plate, IX + 695 pp.
- Day, M. C. 1979. The species of Hymenoptera described by Linnaeus in the genera *Sphex*, *Chrysis*, *Vespa*, *Apis* and *Mutilla*. *Biological Journal of the Linnean Society* 12: 45–84, Errata: 1986. *Sphecos* 12: 20.
- de Beaumont, J. 1950. Sphecidae (Hymenoptera) récoltés en Algérie et au Maroc par M. Kenneth M. Guichard. *Bulletin of the British Museum (Natural History). Entomology* 1: 391–427.
- . 1955. (1954). Hyménoptères récoltés par une mission suisse au Maroc (1947). Sphecidae 3. *Bulletin de la Société des Sciences Naturelles et Physiques du Maroc* 34: 169–197.
- de Beaumont, J., H. Bytinski-Salz, and W. Pulawski. 1973. The Sphecidae (Hym.) of Eretz Israel. III. Subfamilies: Astatinae, Larrinae, Trypoxyloninae, Pemphredoninae, Crabroninae, Oxybelinae. *Israel Journal of Entomology* 8: 1–26.
- Dalla Torre, C. G. 1897. *Catalogus Hymenopterorum hucusque descriptorum systematicus et synonymicus, Volumen VIII: Fossores (Sphegidae)*. Guilelmi Engelmann, Lipsiae. 749 pp.

- Guérin-Méneville, F. E. 1829–1844. *Iconographie du règne animal de G. Cuvier, ou représentation d'après nature de l'une des espèces les plus remarquables et souvent non encore figurées, de chaque genre d'animaux. Avec un texte descriptif mis au courant de la science. Ouvrage pouvant servir d'atlas à tous les traités de zoologie*. Imprimerie de Fain et Thunot, Paris. Livraisons 1–45 (1829–1833) of 10 plates each, livraisons 46–50, p. 1–576 (12 Aug. 1844) consisting of text.
- Haneda, Y. 1971. Sphecidae collected in Formosa in 1970. *The Life Study (Fukui)* 15: 29–33.
- . 1972. Sphecidae collected in Formosa in 1971. *The Life Study (Fukui)* 16: 1–7.
- ICZN. 1973. Opinion 997. *Anoplus* Dufour, 1844 (Insecta, Hymenoptera): designation of a type-species under the plenary powers together with the designation of neotypes for two nominal species. *The Bulletin of Zoological Nomenclature* 30 (1): 25–26.
- Kohl, F. F. 1888. Neue Hymenopteren in den Sammlungen des k. k. naturhistorischen Hofmuseums. III. *Verhandlungen der kaiserlich-königlichen Zoologisch-Botanischen Gesellschaft in Wien* 38: 133–156, pl. III–IV.
- Linnaeus, C. 1758. *Systema Naturae Per Regna Trium Naturae, Secundum Classes, Ordines, Genera, Species, Cum characteribus, differentiis, synonymis, locis*. Tomus I. Editio Decima, Reformata: Laurentii Salvii, Holmiae. [4], [1–5], 6, 823, [1] pp.
- Morice, F. D. 1911. Hymenoptera aculeata collected in Algeria. The Sphegidae (Being Part V of the work commenced by the late Edward Saunders, F.R.S., in Trans. Entomol. Soc., 1901, p. 515). *The Transactions of the Entomological Society of London* 1911: 62–135.
- Murota, T. 1973. Sphecidae, Mutillidae, Scoliidae and Chrysididae collected in Formosa in 1972. *The Life Study (Fukui)* 17: 115–119.
- Nuhn, T., and A. Menke. 1994. Tsuneki holotypes at the National Museum of Natural History, Smithsonian Institution, Washington, D.C. *Sphecos* 28: 24–27.
- Olivier, A. G. 1811. Oxybèle. Pp. 592–598 in A. G. Olivier, and [P. A. Latreille], eds. *Encyclopédie méthodique. Histoire naturelle. Insectes*. Volume 8. H. Agasse, Paris. 720 + 2 unnumbered pp.
- Pagliano, G. 1990. Catalogo degli Imenotteri italiani. II. - Sphecidae. *Bollettino del Museo Regionale di Scienze Naturali - Torino* 8 (1): 53–141.
- Porter, Ch. C., L. A. Stange, and H.-Y. Wang. 1999. Checklist of the Sphecidae of Taiwan with a key to genera (Hymenoptera: Sphecidae). *Journal of the National Taiwan Museum* 52: 1–26.
- Pulawski, W. J. 1962. Les *Tachytes* Panz. de la région paléarctique occidentale et centrale (Hym., Sphecidae). *Polskie Pismo Entomologiczne* 32: 311–475.
- . 1975 (1974). Synonymical notes on Larrinae and Astatinae (Hymenoptera: Sphecidae). *Journal of the Washington Academy of Sciences* 64: 308–323.
- Richards, O. W. 1935. Notes on the nomenclature of the aculeate Hymenoptera, with special reference to British genera and species. *The Transactions of the Royal Entomological Society of London* 83: 143–176.
- Rohwer, S. A. 1911. Descriptions of new species of wasps with notes on described species. *Proceedings of the United States National Museum* 40: 551–587.
- Saunders, E. 1910. Hymenoptera Aculeata collected in Algeria by the Rev. Alfred Edwin Eaton, M.A., F.E.S., and the Rev. Francis David Morice, M.A., F.E.S. Part IV. Descriptions of new Sphegidae. *The Transactions of the Entomological Society of London* 1910: 517–531.
- Schletterer, A. 1887. Die Hymenopteren-Gattung *Cerceris* Latr. mit vorzugsweiser Berücksichtigung der paläarktischen Arten. *Zoologische Jahrbücher. Abtheilung für Systematik, Geographie und Biologie der Thiere*. 2: 349–510, pl. XV.
- Smith, F. 1856. *Catalogue of hymenopterous insects in the collection of the British Museum. Part IV. Sphegidae, Larridae and Crabronidae*. Taylor and Francis, London, p. 207–497.
- Taschenberg, E. L. 1870. Hymenopterologische Ergänzungen zu früheren Arbeiten in dieser Zeitschrift. *Zeitschrift für die Gesamten Naturwissenschaften* 53: 769–783.
- Tsuneki, K. 1963. Chrysididae and Sphecidae from Thailand (Hymenoptera). *Etizenia* 4: 1–50.
- . 1967. Studies on the Formosan Sphecidae (I). The subfamily Larrinae (Hymenoptera). *Etizenia* 20: 1–60.
- . 1971. Studies on the Formosan Sphecidae (XI). A supplement to the subfamily Larrinae (Hymenoptera). *Etizenia* 55: 1–21.
- . 1977. H. Sauter's Sphecidae from Formosa in the Hungarian Natural History Museum (Hymenoptera). *Annales Historico-Naturales Musei Nationalis Hungarici (= A Természettudományi Múzeum Évkönyve)* 69: 261–296.
- Turner, R. E. 1918. Notes on fossorial Hymenoptera.—XXXII. On new species in the British Museum. *Annals and Magazine of Natural History (Series 9)* 1: 86–96.
- Vander Linden, P. L. 1829. Observations sur les Hyménoptères d'Europe de la famille de Fouisseurs, deuxième partie, Bembecides, Larrates, Nyssonien et Crabronites. *Nouvelles Mémoires de l'Académie Royale des Sciences et Belles Lettres de Bruxelles* 5: 1–125.

## Plants Whose Flowers are Utilized by Adults of *Pepsis grossa* Fabricius (Hymenoptera: Pompilidae) as a Source of Nectar

FRED PUNZO

Department of Biology, Box 5F, University of Tampa, 401 W. Kennedy Blvd., Tampa, Florida 33606-1490, USA; email: fpunzo@ut.edu

---

**Abstract.**—The spider wasp, *Pepsis grossa* Fabricius is a common species of wasp found in the Chihuahuan Desert. This study was conducted in Big Bend Ranch State Park (Brewster Co., Texas) and reports on flowers of various plant species used by adults of this wasp as a source of nectar. Although nectar was obtained from the flowers from a total of 19 plant species, four of those species (milkweed: *Asclepias texana* and *A. sperryi*; Mexican Buckeye: *Ungadia speciosa*; Honey Mesquite: *Prosopis glandulosa*) accounted for 73.6% of all plants utilized. The flowers from these plants were all characterized by short corolla tube lengths (<3.5 mm). At this site, *P. grossa* exhibited a narrow trophic niche breadth (Levin's index:  $B = 0.2816$ ). Other common species of plants whose flowers were not visited by these wasps are also identified.

---

Tarantula hawk wasps of the genus *Pepsis* (Hymenoptera: Pompilidae: Pepsinae: Pepsini) are large, long-legged wasps, and are conspicuous components of the arthropod fauna of desert regions of the southwestern United States and Mexico (Punzo 1994a, 2000). The genus *Pepsis* is found in North and South America, and the West Indies, ranging from Utah (latitude 42°N) to Argentina (45°S) (Hurd 1952, Vardy 2002). Although females of these wasps typically hunt and paralyze large spiders as a source of food for their carnivorous larvae (Petrunkévitch 1926, Schmidt 2004), the adults are nectivorous (Williams 1956, Punzo 1994b).

Although there have been some studies on the ecology (Cazier and Mortenson 1964, Field 1992, Punzo 2005), territoriality (Alcock 1979, 2000), hunting behavior (Petrunkévitch 1926, Cazier and Mortenson 1964, Punzo and Garman 1989, Punzo 1994b), neurochemistry (Punzo 1990, 1991), venom chemistry (Schmidt 1990, 2004), morphology of venom glands (Schoeters et al. 1997), and physiology (Punzo 1990) of *Pepsis* wasps, there is a paucity of

information available on the natural history of many species (Punzo 2005).

These wasps are known to obtain nectar from the flowers of a variety of plants (Evans and West-Eberhard 1970, Punzo 2000). However, little information exists on the specific range of plants utilized by any *Pepsis* wasp (Punzo 2005). In desert regions, where ambient temperatures may exceed 43°C during late spring and summer months, female wasps often fly over considerable distances during daylight hours, searching for a suitable host (Vardy 2002, Punzo 2005). Male wasps engage in energetically costly activities as well, including an aggressive aerial defense of territories against intruders (Alcock and Bailey 1997). Insect flight is energetically costly under any circumstance. Thus, it is essential that adult wasps obtain required nutrients in order to survive and reproduce. In addition, because any specific type of plant tissue or nectar may lack some essential dietary requirement, it is only through careful selection of particular plants that an animal can obtain a balanced diet.



The purpose of this study was to identify the species of plants (flowers) visited by adults of *Pepsis grossa* (Fabricius 1798), formerly described as *Pepsis formosa formosa* (Say), in order to obtain nectar. The study was conducted in Big Bend Ranch State Park located in Trans Pecos Texas.

#### DESCRIPTION OF GENERAL STUDY AREA

Big Bend Ranch State Park (BBRSP, Presidio Co., Texas) lies within the northern region of the Chihuahuan Desert. It is bordered to the west by the Rio Grande River (RGR), and climatic conditions range from semi-arid to arid (Parent 1996, Punzo 2000). Mean monthly air temperatures range from 5.1 °C in January to 33.4 °C in July, with low and high temperatures of -10.7 and 45.6 °C, respectively (U.S. Dept. of Interior, 2002). Annual rainfall is typically between 14.6–29.7 cm, depending on location and altitude, with 70–80% occurring from May through October (Medellin-Leal 1992). A wide range of topographic diversity exists within the Park, including igneous rocks, gypsum formations, limestone deposits that provide a variety of substrates including alluvial fans, mountain ridges, canyons, saline playas, gypsum flats, siliceous and gypsum dunes, fine-textured basins, and freshwater seeps and springs (Milford 1991), all supporting a diverse plant fauna with distinct vegetative zones (Powell 1988).

#### MATERIALS AND METHODS

I conducted field studies within the BBRSP in 2003, from late March through September, when plants of this region have well developed flowers. The study site was an area located within a 3.0 km radius of Grassy Banks (29°17'30" N, 103°55'04" W; elevation: 814 m) which is located directly off State Road 170, 6.76 km NW of Lajitas, Texas. The western edge of the site is bordered by the RGR. The soils along the canyon floor are a mixture of sand, gravel and adobe, and support a predominantly

sotol-lechuguilla plant community. The dominant vegetation includes lechuguilla (*Agave lechuguilla*), smooth sotol (*Dasylirion leiophyllum*), ocotillo (*Fouquieria splendens*), mesquites (*Prosopis* spp.), purple sage (*Leucophyllum frutescens*), creosote (*Larrea divaricata*), false agave (*Hechtia texensis*), tarbrush (*Flourensia cernua*), catclaw acacia (*Acacia berlandieri*), prickly pear cacti (*Opuntia* spp.), yuccas (*Yucca* spp.), and scattered clumps of milkweed (*Asclepias sperryi*) and grasses, including chino gramma (*Bouteloua brevifolia*), fluffgrass (*Erioneuron pulchellum*), and beargrass (*Nolina erumpens*). Numerous large rocks and boulders are scattered along the canyon floor, and the canyon walls are comprised mainly of sandstone, limestone, and igneous rock.

*Pepsis grossa* (Fabricius) is the most common *Pepsis* wasp at this location (Punzo 2000). Males can be observed in flight either moving between flowers or defending territories, feeding at flowers, or resting on various bushes and plants. Females are readily visible, flying in search of hosts or food plants, or walking rapidly over the ground surface exploring various crevices and burrows for suitable spiders.

Twenty square-shaped transects were established within the study site. The dimension of each transect was 54 m<sup>2</sup>. With the aid of several field assistants, I walked through each transect in a linear fashion, following paths delineated by small yellow cords placed along the ground in an east-west direction, and separated by a distance of 6 m. Adult wasps were collected using sweep nets. We recorded the following data for each wasp observed and collected: (1) time of collection (Central Standard Time, CST); (2) sex; (3) if feeding, the species of plant (flower) being utilized; (4) type of plant for wasps observed resting on vegetation; (5) for flowers at which wasps were observed feeding, flowers were collected and length of the corolla tube was measured to the

Table 1. Species of plants whose flowers were used as a source of nectar (percent utilization) by adults of *Pepsis grossa* at a study site (Grassy Banks) located within Big Bend Ranch State Park, Brewster Co, Texas, during 2003. Data expressed as percentage utilization of 19 food resources. Data pooled for males (*n* = 504) and females (*n* = 488). Scientific and common names of plants based on Powell (1988). *B* = Levin’s measure of trophic niche breadth.

Plant species	Mean corolla length (mm) (± SE)	Percent utilization
<i>Asclepias texana</i> Torrey (Texas Milkweed)	3.45 (0.41)	28.4
<i>A. sperryi</i> Woods (Sperry Milkweed)	3.55 (0.23)	17.9
<i>Ungadia speciosa</i> Endler (Mexican Buckeye)	2.95 (0.23)	16.1
<i>Prosopis glandulosa</i> Benson (Honey Mesquite)	3.35 (0.28)	11.2
<i>P. pubescens</i> Gray (Screwbean Mesquite)	4.29 (0.18)	3.5
<i>Lycium pallidum</i> Correll (Pale Wolfberry)	5.04 (0.31)	1.7
<i>Diospyros texana</i> Scheele (Texas Persimmon)	5.23 (2.45)	3.6
<i>Agave lechuguilla</i> Torrey (Lechuguilla)	6.02 (2.06)	3.1
<i>Yucca treculeana</i> Correll (Spanish Dagger)	6.78 (3.03)	3.1
<i>Y. rostrata</i> Engelman (Beaked Yucca)	6.02 (1.87)	0.6
<i>Dasyllirion texanum</i> Scheele (Texas Sotol)	5.75 (1.93)	1.8
<i>D. leiophyllum</i> Engelman (Desert Candle)	7.25 (2.11)	0.5
<i>Opuntia imbricata</i> Hawes (Cane Cholla)	7.43 (2.04)	2.7
<i>O. schottii</i> Engelman (Dog Cholla)	8.02 (2.18)	1.6
<i>O. phaeacantha</i> Engelman (Purple-fruited Pricklypear)	7.47 (1.99)	0.6
<i>Salvia greggi</i> Gray (Autumn Sage)	4.48 (0.32)	1.8
<i>Forestiera angustifolia</i> Torrey (Desert Olive)	8.04 (1.97)	1.1
<i>Nolina erumpens</i> Torrey (Bear grass)	4.88 (0.67)	0.3
<i>Senecio douglasii</i> Benson (Groundsel)	7.79 (1.08)	0.1
		<i>B</i> = 0.2816

nearest mm using a portable Unitron dissecting microscope fitted with an ocular measuring grid; (5) species of plants where wasps were not observed to visit flowers. Only those wasps that extended their tongues into the corolla, or that were observed to enter the corolla tube of flowers with their entire head capsules (and in some cases, part of the thorax as well) and remain there for at least 20 sec were considered to be in the act of feeding. Each of these wasps was collected, frozen on dry ice, and taken back to the laboratory to confirm feeding by dissecting the gut and analyzing gut contents.

Trophic niche breadth was determined using the standardized Levin’s index (*B*) (Levins 1968):  $B = 1 / \sum p_j^2$ , where  $p_j$  represents the proportion of individuals (percent utilization) found on a particular resource (plant species–flower). Values for this measure can range from 0 (narrowest trophic niche: all resources fall under one resource category) to 1.0 (resources represented equally in all categories).

RESULTS AND DISCUSSION

During daylight hours, male and female wasps were observed resting on shaded areas of leaves or branches of cottonwood (*Populus fremontii*), willows (*Salix taxifolia* and *S. interior*), walnut (*Juglans microcarpa*), oak (*Quercus oblongifolia*), mesquite (*Prosopis pubescens* and *P. glandulosa*), persimmon (*Diospyros texana*), milkweed (*Asclepias speciosa* and *A. sperryi*), Mexican buckeye (*Ugnadia speciosa*), leatherstem (*Jatropha dioca*), and soapberry (*Sapindus saponaria*). These same trees were used as perch sites by males during April and May, when activities associated with territorial defense and breeding are most intense (Cazier and Mortenson 1964, Punzo 2000, 2005).

The species of plants whose flowers were used as a source of nectar by adults of *P. grossa* are listed in Table 1. This represents the first detailed list of specific food plants for a wasp in this genus. Because no significant differences were found between males (*n* = 504) and

Table 2. Species of plants common at the Grassy Banks study site in Big Bend Ranch State Park whose flowers were not observed to be visited and used as sources of nectar by adult males or females of *Pepsis grossa* as sources of nectar. Scientific and common names of plants based on Powell (1988). Data on corolla tube length (mm) expressed as means ( $\pm$  SE); N = number of each plant species.

Species	N	Corolla tube length (mm)
<i>Aloysia gratissima</i> Tronc. (Whitebrush)	617	10.05 (1.74)
<i>Amsonia longiflora</i> Torr. (Bluestar)	448	9.02 (1.87)
<i>Cowania ericifolia</i> Torr. (Heath Cliff Rose)	194	7.79 (1.21)
<i>Croton docius</i> Cav. (Grassland Croton)	847	5.81 (0.44)
<i>Euphorbia antispyphilatica</i> Zucc. (Candelilla)	524	5.06 (1.12)
<i>Fallugia paradoxa</i> Endl. (Apache Plume)	456	8.05 (1.89)
<i>Fouquieria splendens</i> Engelm. (Ocotillo)	905	13.84 (4.02)
<i>Hibiscus coulteri</i> Harv. (Desert Rosemallow)	389	7.52 (1.09)
<i>Justica warnockii</i> Turner (Warnock Justicia)	197	5.94 (0.68)
<i>Krameria glandulosa</i> Torr. (Range Krameria)	295	4.35 (0.38)
<i>Lantana macropoda</i> Torr. (Vinyleaf Lantane)	428	13.21 (2.05)
<i>Mendora longiflora</i> Gray (Showy Mendora)	236	14.56 (2.77)
<i>Leucophyllum frutescens</i> Berl. (Purple Sage)	683	11.93 (2.97)
<i>Selinocarpus parvifolias</i> Standl. (Little Moonpod)	379	16.84 (5.25)
<i>Senna wislizenii</i> Gray (Senna)	257	4.76 (0.46)

females ( $n = 488$ ) (Chi square test:  $X^2 = 1.06$ ,  $P > 0.06$ ), data in Table 1 are pooled for both sexes. Results indicate that at this study site, adults of *P. grossa* utilize the flowers of 4 out of 19 plant species considerably more frequently than the others, which is also reflected in the value obtained for Levin’s index. It should also be pointed out that flowers of the most frequently used species have the shortest corolla lengths. These four species accounted for 73.6% of the plants whose flowers provided these wasps with nectar.

In contrast, wasps were never observed feeding from the flowers of other plant species that were commonly found at this site (Table 2). Ten of these 15 species have flowers whose corolla lengths are in excess of 7 mm, and 6 have values greater than 10 mm. In view of this, as well as from the data in Table 1 on the four most-utilized plant species, these results suggest that adults of *P. grossa* prefer flowers with short corolla lengths. However, a number of species listed in Table 1 and 2, with corolla lengths less than 6 mm, were visited infrequently or not at all by these wasps, suggesting that other properties, in addition to corolla length, may influence

suitability of flowers as a food source.

According to a few previous reports, *Pepsis* wasps from the southwestern United States have been observed visiting the flowers of a number of families of suffrutescent and woody flowering plants (Lincecum 1867, Hurd 1948), although no systematic attempt was made to identify the species of possible food source plants. Lincecum (1867) was the first to observe an apparent preference of these wasps for flowers of milkweed plants of the genus *Asclepias*, which is in agreement with the results of this study. In addition, these wasps play an important role in the pollination of milkweed plants (Hurd 1948).

In conclusion, the relatively narrow trophic niche breadth exhibited by adults of *P. grossa*, coupled with the fact that flowers from all of the plants listed in Tables 1 and 2 are common throughout the spring and early summer at this study site, indicates a preference for the flowers of *Asclepias* species and *Prosopis glandulosa*. It is interesting to note that flowers of another mesquite species, *P. pubescens*, are visited far less frequently than those of *P.*



*glandulosa*, even though these plants are often found in close proximity. These wasps may be using species-specific visual, olfactory and/or gustatory cues to make decisions as to which flowers to feed on. Other species of nectivorous insects, including various species of butterflies and bees, are known to use combinations of these types of cues to choose sources of nectar (Heinrich 1979, Stone 1994).

## ACKNOWLEDGMENTS

I thank J. Bottrell, K. Smart, L. Ludwig, P. Trepekan, and B. Cummins for assistance in observing wasps and recording data in the field, A. Simmons, G. Broad, S. Cameron, and anonymous reviewers for commenting on an earlier draft of the manuscript, and the University of Tampa for providing me with financial support (Faculty Development Grant) for this project. Field studies were conducted with permission from the Texas Dept. of Parks and Wildlife (Permit #: 41-03).

## LITERATURE CITED

- Alcock, J. 1979. The behavioral consequences of size variation among males of the territorial wasp, *Hemipepsis ustulata* (Hymenoptera: Pompilidae). *Behaviour* 71: 322-335.
- , 2000. Possible causes of variation in territory tenure in a lekking pompilid wasp (*Hemipepsis ustulata*) (Hymenoptera). *Journal of Insect Behavior* 13: 439-453.
- , and W. J. Bailey. 1997. Success in territorial defense by male tarantula hawk wasps *Hemipepsis ustulata*: the role of residency. *Ecological Entomology* 22: 377-383.
- Cazier, M. A., and M. Mortenson. 1964. Bionomical observations on tarantula hawks and their prey (Hymenoptera: Pompilidae): *Pepsis*. *Annals of the Entomological Society of America* 57: 533-541.
- Evans, H. E., and M. J. West-Eberhard. 1970. *The Wasps*. University of Michigan Press; Ann Arbor, Michigan. vii + 265 pp.
- Field, J. 1992. Guild structure in solitary spider-hunting wasps (Hymenoptera: Pompilidae) compared with null model predictions. *Ecological Entomology* 17: 198-208.
- Heinrich, B. 1979. *Bumblebee Economics*. Harvard University Press, Cambridge, Massachusetts. x + 381 pp.
- Hurd, P. D. 1948. Systematics of the California species of the genus *Pepsis* Fabricius (Hymenoptera: Pompilidae). *University of California Publications in Entomology* 8: 123-150.
- , 1952. Revision of the Nearctic species of the pompilid genus *Pepsis* (Hymenoptera: Pompilidae). *Bulletin of the American Museum of Natural History* 98: 260-234.
- Levins, R. 1968. *Evolution in Changing Environments: Some Theoretical Explanations*. Princeton University Press, Princeton, New Jersey. xi + 418 pp.
- Lincecum, G. 1867. The tarantula killers of Texas. *American Naturalist* 1: 137-141.
- Medellin-Leal, F. 1992. The Chihuahuan Desert. pp. 321-382 in: G. L. Bender ed. *Reference Handbook on the Deserts of North America*. Greenwood Press, Westport, Connecticut.
- Milford, M. H. 1991. *Introduction to Soils and Soil Science*. Kendall-Hunt, Dukesne, Iowa. vii + 378 pp.
- Parent, L. 1996. *Big Bend National Park*. Falcon Publishing, Inc., Helena, Montana. viii + 171 pp.
- Petrunkévitch, A. 1926. Tarantula versus tarantula hawk: a study in instinct. *Journal of Experimental Zoology* 45: 367-397.
- Powell, A. M. 1988. *Trees and Shrubs of Trans-Pecos Texas*. Big Bend Natural History Association, Big Bend, Texas. 536 pp.
- Punzo, F. 1990. The hemolymph composition and neurochemistry of the spider wasp, *Pepsis formosa* (Say) (Hymenoptera: Pompilidae). *Comparative Biochemistry and Physiology* 96A: 341-345.
- , 1991. Neurochemical events associated with learning and hunting behavior in the spider wasp, *Pepsis formosa* (Hymenoptera: Pompilidae). *Florida Scientist* 54: 51-61.
- , 1994a. The biology of the spider wasp, *Pepsis thisbe* (Hymenoptera: Pompilidae) from Trans Pecos Texas. I. Adult morphometrics, larval development and the ontogeny of larval feeding patterns. *Psyche* 10: 229-241.
- , 1994b. The biology of the spider wasp, *Pepsis thisbe* (Hymenoptera: Pompilidae) from Trans pecos Texas. II. Temporal patterns of activity and hunting behavior with special reference to the effects of experience. *Psyche* 101: 243-256.
- , 2000. *Desert Arthropods: Life History Variations*. Springer; Heidelberg, Germany. xi + 301 pp.
- , 2005. Studies on the natural history, ecology and behavior of *Pepsis cerberus* and *Pepsis mexicana* (Hymenoptera: Pompilidae) from Big Bend National Park, Texas. *Journal of the New York Entomological Society* 113: 84-95.
- , and B. Garman. 1989. Effects of encounter experience on the hunting behavior of the spider wasp, *Pepsis formosa* (Say) (Hymenoptera: Pompilidae). *Southwestern Naturalist* 34: 513-518.
- Schmidt, J. O. 1990. Hymenoptera venoms: striving toward the ultimate defense against Vertebrates. pp. 387-419 in: Evans, H. and J. O. Schmidt, eds. *Insect Defense: Adaptations and Strategies of Prey and*

- Predators*. State University of New York Press, Albany, New York.
- , 2004. Venom and the good life in tarantula hawks (Hymenoptera: Pompilidae): how to eat, not be eaten, and live long. *Journal of the Kansas Entomological Society* 77: 402–413.
- Schoeters, E., J. O. Schmidt, and J. Billen. 1997. Venom gland morphology in *Pepsis pallidolimbata pallidolimbata* and biological use and activity of *Pepsis* venom. *Canadian Journal of Zoology* 75: 1014–1019.
- Stone, G. N. 1994. Activity patterns of females of the bee *Anthophora plumipes* in relation to temperature, nectar supplies and body size. *Ecological Entomology* 19: 177–189.
- U. S. Department of Interior. 2002. Division of Publications, National Park Service, National Park handbook, No. 119, Washington, D.C., 209 pp.
- Vardy, C. R. 2002. The New World tarantula-hawk genus *Pepsis* Fabricius (Hymenoptera: Pompilidae). Part 2. The *P. grossa* to *P. deaurata* groups. *Zoologische Verhandelingen* 338: 1–135.
- Williams, F. X. 1956. Life history studies of *Pepsis* and *Hemipepsis* wasps in California (Hymenoptera: Pompilidae). *Annals of the Entomological Society of America* 49: 447–466.

## NOTE

### *Polistes goeldii* (Hymenoptera: Vespidae) is a Widespread but Rare Social Wasp

CHRISTOPHER K. STARR\* AND ALLAN W. HOOK

(CKS) Dep't of Life Sciences, University of the West Indies, St Augustine, Trinidad & Tobago;  
email: ckstarr99@hotmail.com

(AWH) Dep't of Biology, St Edward's University, Austin, Texas 78704, USA;  
email: hook@acad.stedwards.edu

\*Address for correspondence: Christopher K. Starr, Dep't of Life Sciences, University of the West Indies, St Augustine, Trinidad & Tobago; tel (868) 662-2002 ext 3096 or 645-3232 ext 3096;  
fax (868) 663-5241 or 663-9864; ckstarr99@hotmail.com

*Key words:* *Polistes*, neotropical, social wasp

*Polistes goeldii* Ducke was described from the Amazon region of Brazil. It is a large, robust social wasp, metallic blue-black except for the mandibles and lower part of the clypeus, which are reddish. Given its size and color pattern, it bears a striking resemblance to some members of the genus *Synoecca*, especially the widespread *S. septentrionalis* Richards and *S. surinamensis* (L.). Although *P. goeldii* can presumably deliver a powerful sting, it has very small colonies in comparison with the fearsome *Synoecca* spp., so that the resemblance between the two is almost certainly batesian mimicry. That is, it seems out of the question that *Synoecca* gains any defensive advantage from potential predators' experience with *P. goeldii*.

*Polistes goeldii* is a distinctive wasp with an even more distinctive nest. In September 2004 we found an active colony of this species at Caura Village, Trinidad, West Indies with a nest matching in its overall form all others that we have seen and that have been described to us, as well as a description by Richards (1978:522). It was a single comb hanging from a highly excentric petiole, attached to a fence wire a little over one meter from the ground. The petiole was relatively stout, about

3 mm long. The comb consisted of 22 cells in just two rows, each cell attached some distance below the base of its predecessor, so that the comb descended sharply from the petiole (Figs. 1–2). The largest nest of this species of which we are aware had just 52 cells (Richards 1978:522).

The cell material was medium-gray carton. The petiole and the comb top around it were covered in shiny black varnish, which was also applied in spots elsewhere on the comb. Newer cells showed less varnish than older ones, consistent with the wasps periodically applying it over the entire comb. The pupal caps bulged moderately below the cell mouths. They had only slight daubs of pulp applied to them but were abundantly spotted with dark varnish.

Over the course of three days we never saw more than two adult females on the nest, presumably the full number at that stage. Three cells had fecal pellets in their bases (Fig. 2), indicating that each had produced an adult and now contained a second brood individual. The walls of these cells were cut back to make them much shorter (Fig. 1).

Richards (1978) recorded *P. goeldii* from a few localities in Brazil, Colombia, Ecua-





Fig. 1. *Polistes goeldii* colony in place at Caura Village, Trinidad, West Indies. The length of the comb is 128 mm. The upper wasp's mid- and hind-legs straddle cells that have been cut back.

dor and Peru, as well as from "Salvador". The identity of this latter is uncertain, but it may refer to the city of that name in Bahia state, Brazil. The published range of *P. goeldii*, therefore, comprises an equatorial belt over about 13 degrees of latitude on both sides of the Andes.

In fact, the species is much more widespread. Fig. 3 shows the presently known localities of *P. goeldii*. These are based on specimens that we have examined in the National Institute for Biodiversity (INBio) in Costa Rica, Museum of the Institute Agricultural Zoology (MIZA) of the Central University of Venezuela, and Land Arthropod Collection of the University of the West Indies (UWI) in Trinidad & Tobago, and personal communications from J.M. Carpenter, J.H. Hunt, R.L. Jeanne and W.L. Overal, as well as Richards'

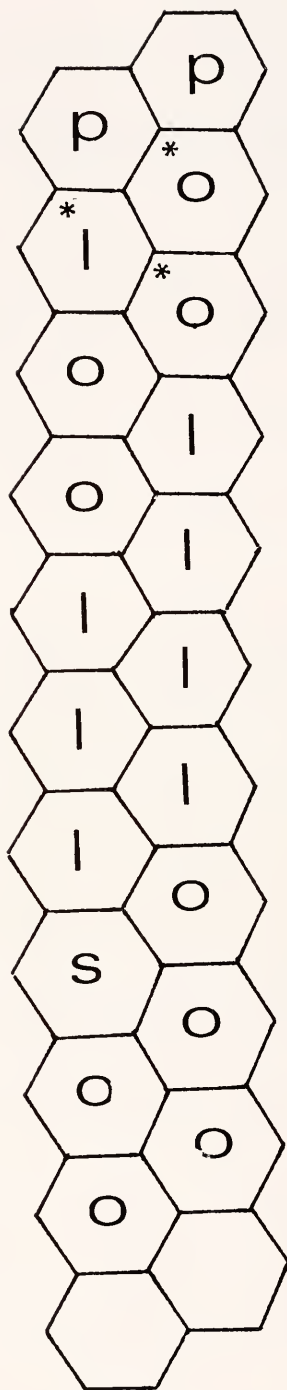


Fig. 2. Cell map of the nest shown in Fig. 1. Cell contents: l large larva (probably instar 4-5), o egg or instar-1 larva, p with pupal cap, s small larva (probably instar 2-3). The two lowest cells were empty. Asterisked cells have a fecal pellet. The petiole was attached to the top-most cell.



Fig. 3. Central America and northern South America, to show known localities of *Polistes goeldii*.

(1978) records with the exception of “Salvador”.

It is remarkable that the broad range of such a distinctive wasp should have gone unrecognized until now. The most likely explanation is that *P. goeldii* is rare wherever it occurs. As an example, at the time we encountered the colony shown in Fig. 1 the authors had a combined residence of about 16 years in Trinidad and had long since come to suppose that we had recorded all social wasp species existing in the island. Yet this colony was nesting just a few hundred meters from our residence.

*P. goeldii* bears a strong overall resemblance to *P. aterrimus* Saussure, presumably also a batesian mimic of *Synuoeca* spp.

The two are most readily distinguished by the pronotal keel (sharp and extensive in each, but smoothly curving in *P. goeldii*, versus with distinct humeral “shoulders” in *P. aterrimus*) and the propodeal striae (confined to the median furrow in *P. goeldii*, versus extending strong onto the sides in *P. aterrimus*), as well as by their nests (*P. aterrimus* with a broad comb from an excentric petiole, as in many other neotropical species). The two species overlap very broadly in their ranges, although there is a more or less distinct altitudinal separation, *P. aterrimus* being found at higher elevations.

Based on museum specimens, *P. aterrimus* appears to be much more common than *P. goeldii*. In the INBio collection we

found just six specimens of *P. goeldii*, versus 59 of *P. aterrimus*. The corresponding figures for the MIZA collection are five and 41. Similarly, the combined insect museums of Colombia have four specimens of *P. goeldii* and 32 of *P. aterrimus* (C.E. Sarmiento, pers. comm.). In no case is the preponderance of *P. aterrimus* specimens due to a large nest series, so that the comparison appears to be fair.

We have seen *P. goeldii* at Belém, Pará, Brazil, one of the type localities, and R.L. Jeanne and W.L. Overal (pers. comms.) report seeing it there as well. Even at Belém, however, it appears to be uncommon.

Across a broad range of plants and animals, there is a clear positive correlation between geographic range size and local abundance (Gaston 2003:115–16). We are not aware that this rule has been examined with respect to any group of social insects, but it is our definite impression that it applies well to neotropical social wasps. Such very widespread species as *Polistes versicolor* (Olivier) and *Polybia rejecta* (F.), for example, seem to be abundant almost everywhere that they are found, while we know of no very restricted species – with the exception of some endemic to the oceanic islands of the Antilles – that one would characterize as common.

*P. goeldii*, then, appears to present a striking exception to this rule. This suggests that its niche is somehow unusually narrow for its genus. A good place to look would be in its feeding habits.

The scant evidence available suggests that colonies are characteristically small

and that nests never become large. It is noteworthy that the Trinidad nest, comprising just 22 cells, had already produced three adults and two pupae. A small colony and nest proffer the possibility of cryptic escape from predators, and several features of the nest are consistent with such an approach. The narrowness of the steeply-hanging comb allows it to resemble a short vine, something quite outside of a predator's search image derived from common species. This resemblance is enhanced by the application of dark varnish on much of the comb. The removal of carton from cells from which adults had emerged may be an economy measure to conserve material, or it may be a way of diminishing the profile of the comb for a time.

If predators and entomologists find *P. goeldii* hard to locate, it is possible the wasps themselves have difficulty finding mates. It would be interesting to know if this species has special adaptations in this respect.

We thank the journal's reviewers (Sean O'Donnell and Justin O. Schmidt) for criticism of an earlier version of this note and Azad Mohammed and Rajesh Ragoo for help with the figures.

#### LITERATURE CITED

- Gaston, K. J. 2003. *The Structure and Dynamics of Geographic Ranges*. Oxford University Press, Oxford.
- Richards, O. W. 1978. *The Social Wasps of the Americas, Excluding the Vespinae*. British Museum (Natural History), London.



## INSTRUCTIONS FOR AUTHORS

**General Policy.** The Journal of Hymenoptera Research invites papers of high scientific quality reporting comprehensive research on all aspects of Hymenoptera, including biology, behavior, ecology, systematics, taxonomy, genetics, and morphology. Taxonomic papers describing single species are acceptable if the species has economic importance or provides new data on the biology or evolution of the genus or higher taxon. Manuscript length generally should not exceed 50 typed pages; however, no upper limit on length has been set for papers of exceptional quality and importance, including taxonomic monographs at generic or higher level. All papers will be reviewed by at least two referees. The referees will be chosen by the appropriate subject editor. However, it would be helpful if authors would submit the names of two persons who are competent to review the manuscript. The language of publication is English. Summaries in other languages are acceptable.

**The deadline for receipt of manuscripts is 1 September (for the April issue) and 1 March (for the October issue).**

**Format and Preparation.** Authors are strongly encouraged to submit manuscripts electronically to the editor at the email address below, and in the format specified below. If this is not possible then three copies of each manuscript, including copies of illustrations, should be submitted on letter size or A4 paper, double spaced, with at least 25 mm margins on all sides. On the upper left of the title page give name, address, telephone and fax numbers, and email address of the author to whom all correspondence is to be sent. The paper should have a concise and informative title, followed by the names and addresses of all authors. The sequence of material should be: title, author(s), abstract, text, acknowledgments, literature cited, appendix, figure legends, figure copies (each numbered and identified), tables (each numbered and with heading). Each of the following should start a new page: (1) title page, (2) abstract, (3) text, (4) literature cited, (5) figure legends, (6) footnotes.

Upon final acceptance of a manuscript, the author should provide the editor with an emailed IBM formatted electronic version. CD-ROMs or 3.5 inch floppy disks are acceptable. Because symbols and tables are not always correctly translated it is best to also send a printed copy of the manuscript. Preferred word processing programs are Microsoft Word and WordPerfect. If possible, all words that must be italicized should be done so, not underscored. Tables may be formatted in a spread sheet program such as MS Works or MS Excel. Text should be double-spaced typing, with 25 mm left and right margins. Tables should be put in a separate file. CDs and Diskettes should be accompanied by the name of the software program used (e.g., WordPerfect, Microsoft Word). Authors should keep backup copies of all material sent to the Editor. The Society cannot be responsible for diskettes or text mislaid or destroyed in transit or during editing.

Illustrations should be planned for reduction to the dimension of the printed page (14 × 20.5 cm, column width 6.7 mm) and allow room for legends to at the top and bottom. Do not make plates larger than 14 × 18 in. (35.5 × 46 cm). Individual figures should be mounted on a suitable drawing board or similar heavy stock. Photographs should be trimmed, grouped together and abutted when mounted. Figure numbers should be on the plate. Include title, author(s) and address(es), and illustration numbers on back of each plate. Original figures need not be sent until requested by the editor, usually after the manuscript has been accepted. Reference to figures/tables in the text should be in the style "(Fig. 1)" "(Table 1)". Measurements should be in the metric system.

Electronic plates may be submitted on disc, via email or uploaded to an ftp site (instructions will be given). They must be fully composited, labeled, and sized to fit the proportions of the journal page. Line art should be scanned at 1200 dpi (minimum input resolution is 600 dpi). Color or grayscale (halftone) images should have a dpi of 300-350. Color files should be in CMYK and not RGB. Graphics should be submitted as TIFF, Adobe Illustrator or EPS files. No PowerPoint or Word/WordPerfect files with images embedded in them are acceptable.

All papers must conform to the *International Code of Zoological Nomenclature*. The first mention of a plant or animal name should include the full scientific name including the authority. Genus names should not be abbreviated at the beginning of a sentence. In taxonomic papers type specimens must be clearly designated, type depositories must be clearly indicated, and new taxa must be clearly differentiated from existing taxa by means of keys or differential diagnoses. Authors are required to deposit all type material in internationally recognized institutions (not private collections). Voucher specimens should be designated for specimens used in behavioral or autecological studies, and they should be deposited similarly.

Acceptance of taxonomic papers will not require use of cladistic methods; however, authors using them will be expected to specify the phylogenetic program used (if any), including discussion of program options used. A data matrix should be provided if the subject is complex. Cladograms must be hung with characters and these should include descriptors (not numbers alone) when feasible. The number of parsimonious cladograms generated should be stated and reasons given for the one adopted. Lengths and consistency indices should be provided. Adequate discussions should be given for characters, plesiomorphic conditions, and distributions of characters among outgroups when problematical.

References in the text should be (Smith 1999), without a comma, or Smith (1999) Two articles by a single author should be (Smith 1999a, 1999b) or Smith (1999a, 1999b). For multiple authors, use the word "and," not the symbol "&" (Smith and Jones 1999). For papers in press, use "in press," not the expected publication date. The Literature Cited section should include all papers referred to in the paper. Journal names should be spelled out completely and in italics.

**Charges.** Publication charges are \$10.00 per printed page. At least one author of the paper must be a member of the International Society of Hymenopterists. Reprints are charged to the author and must be ordered when returning the proofs; there are no free reprints. Author's corrections and changes in proof are also charged to the author. Color plates will be billed at full cost to the author.

All manuscripts and correspondence should be addressed to:

Dr Gavin Broad  
Centre for Ecology & Hydrology  
Monks Wood, Abbots Ripton  
Huntingdon PE28 2LS, UK

Phone: +44(0)1487 772406; FAX: +44(0)1487 773467; Email: gabro@ceh.ac.uk

SMITHSONIAN INSTITUTION LIBRARIES



3 9088 01210 6548